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## Light-Draft Stern-Wheel Suction Dredge for Navigation Improvement on the Niger.

A light-draft suction dredge of convenient type has been built recently for channel dredging in the Niger River, Africa. The drawings and views Figs. 1-3 herewith show the general features of this vessel. Its designer, Mr. A. W. Robinson, of Montreal, Que., has also given us a description of the dredge, from which the following abstract has been prepared.

The River Niger is somewhat similar to the Mississippi, and it was the good results obtained in seasonal dredging by the Mississippi River Commission that led the Government of Nigeria to consider using this method of improvement there. The Niger in fact presents a simpler problem, because it runs between comparatively permanent banks, and its channel does not change location extensively. Navigation improvement becoming necessary, the dredging plan was adopted in 1908 by Sir Percy Girouard, then High Commissioner of Northern Nigeria, and Mr. Robinson was commissioned with the design of a special dredge for the purpose.

The Niger is an alluvial stream subject to great range of level. In the reach of 300 miles between Abo and Baro where the principal work is to be done, there is a navigation depth of 14 ft. during the high water season, but at low water the depth diminishes to 1 or 2 ft., being obstructed by constantly shifting sand-bars. The condition of the river has given rise to a special class of light-draft steamer to carry on the navigation during the low-water season, even down to a "steam canoe" which can carry 5 tons on a draft of 18 ins. But to supplement the railway project now under way in northern Nigeria, better facilities for river navigation are needed. Permanent works for this purpose are hardly in question in an unstable channel like that of the Niger, and dredging on the bars during falling water seemed to offer the best prospect for success.

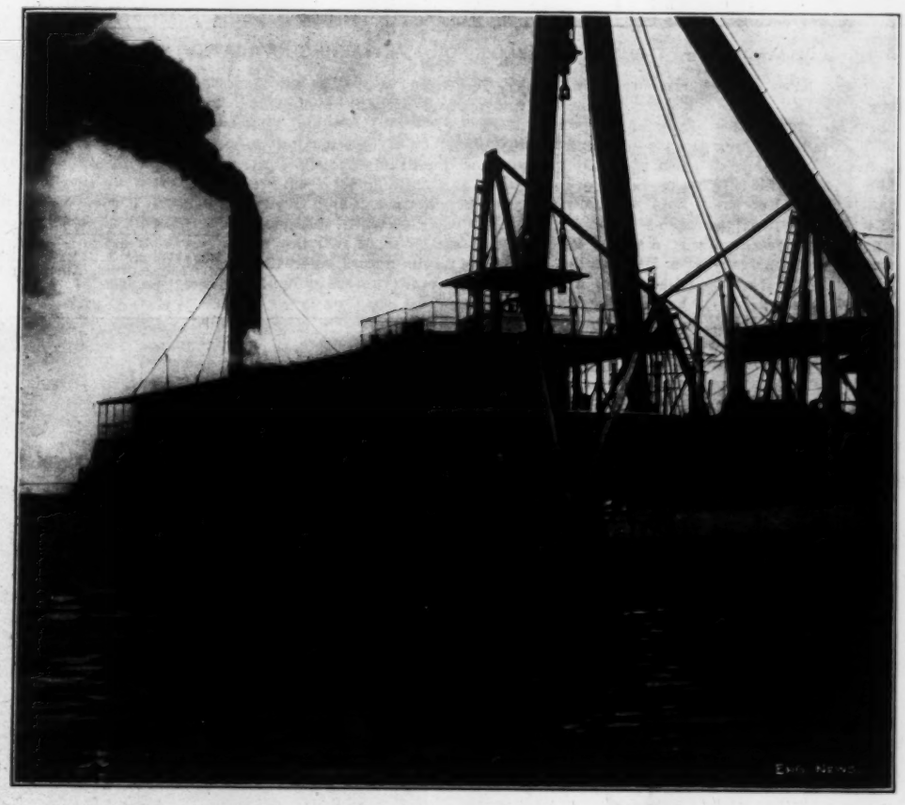
REQUIREMENTS.—The problem resolved itself into the design of a dredge which could rapidly and cheaply cut a channel across the sand-bars along the line of the current, of sufficient width and depth to pass a steamer of say 5 or 6 ft. draft, and so that the cutting once opened in this way would tend to maintain itself by natural erosion with but little attention for the balance of the season (as it is found to do on the Mississippi). The vessel should have shallow draft, not over 3 ft. in working trim, and should be able to make its own flotation, set out and pick up its own anchorages, and go quickly from place to place with its floating pipe-line, coal barge, etc., so as to maintain navigation at the critical points as the river level falls.

GENERAL SKETCH.—The vessel designed and subsequently built is a light-draft stern-wheel steamer fitted with a suction pipe at the front end. The suction head broadens out in the shape of a fan, with the inlet opening at the front 16 ft. wide. Thus the machine is able to make a very wide cut with a straight forward feed. While the actual width of cut is 16 ft. on the bottom, the sides will run in to such a slope that the channel made is quite sufficient to pass the vessel. The suction head can be lowered to a depth of 12 ft.

By means of a self-deflecting floating pipe-line, the dredge deposits the sand in the river off at one side, far enough away so that it will not run back into the dredged channel.

ANCHORAGE PILES.—The dredge feeds itself forward by means of two anchorage lines ahead, handled by a steam winch on the forward deck which also raises and lowers the suction pipe. For attaching the lines, two steel piles are sunk in the river bottom by the dredge before beginning dredging. At the front of the vessel are two pairs of light steel sheer-legs, which overhang the sides; these place and hold the piles while being jetted down. The anchor piles are steel tubes, closed at the top but open at the bottom, fitted with a jet pipe and hose connection. The sinking, in the sand bottom, takes only a few minutes. The piles are sunk at the upstream end of the bar to be dredged, then the vessel attaches its head-lines and drops downstream to the lower end of the bar. It then dredges up through the bar by winding in on the anchorage lines at such a rate as to feed the pump with sand up to its maximum capacity. A vacuum gage in front of the operator furnishes a guide for the tax on the pump, hence on the proper rate of feeding.

DREDGING PUMP.—The pumping set is located on the forward part of the main deck. It is a direct-connected set consisting of a centrifugal pump and a Bellis & Morcom triple-expansion engine of high-speed enclosed type with forced lubrication. The normal speed is 300



LIGHT-DRAFT SUCTION DREDGE FOR RIVER NIGER.
(At yards of builders, Lobnitz & Co., of Renfrew, Scotland, ready for voyage out.)

r. p. m., and normal power is 300 to 400 HP., though the engines can work up to higher capacity when necessary to pump against high head or long discharge distance.

The pump was specially designed by Mr. Robinson. In accordance with the high speed, it is proportioned with a small impeller-diameter, and at the same time wide passages to pass any entering solids freely. The suction and discharge pipes are 24 ins. in diameter.

The set is well adapted to working in a country where skilled engine-runners are scarce, the automatic lubrication enabling it to run with a minimum of regular attention.

Steam is supplied by two boilers of the locomotive type. They are designed to use either coal or wood, and for this purpose have extra large fireboxes and double doors.

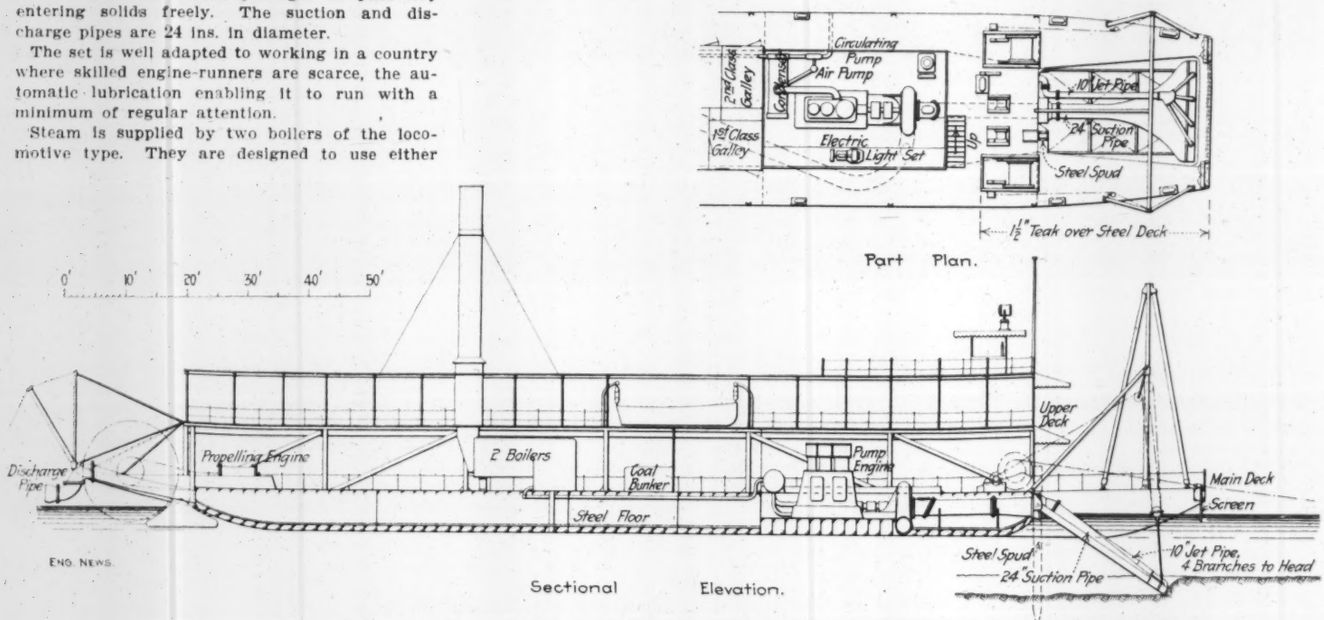



FIG. 2. STERN-WHEEL SHALLOW-DRAFT SUCTION DREDGE FOR MAINTAINING NAVIGATION CHANNEL IN RIVER NIGER.

DISCHARGE PIPE.—The discharge pipe passes from the pump laterally, and curves in a long elbow backward to the stern on the longitudinal center line of the vessel. The paddle-wheel is divided to pass the pipe. At the rear end of the fixed pipe is a swivel elbow to which the floating pipe attaches, giving the latter complete freedom of angular motion both vertically and horizontally.

The floating discharge pipe used when dredging in the river is ordinarily about 400 ft. long, carried on seven circular steel pontoons. The joints are special, fitted with springs in such a way as to maintain the pipe in a straight line normally but permitting deflection under stress. At the outer end of the pipe is a steel baffle-plate which can be turned at any angle required so as to act as a rudder and thus steer the entire pipe-line to either one side of the dredge or the other as desired. The reaction of the issuing stream of water impinging against this rudder is sufficient to sustain the pipe-line at right angles to the dredge against the force of a moderate current. In this way the dredged material is discharged to one side or the other entirely clear of the channel.

PROPELLING ENGINE.—The propelling engine is of the usual stern-wheel compound condensing type.

OPERATING CONTROL.—All the operations of the dredge are under the direct control of one man from the operating platform on the upper deck. Here are arranged all the levers which control the various movements of the winch and also the pressure and vacuum gages for the various purposes, and signals to the engineer. The pilot-house is also fitted with the usual steering apparatus, etc., for use when the vessel is navigating. Officers' and crew's quarters are fitted on the upper deck.

TRIAL PERFORMANCE. — The dredge was ordered, by the Crown Agents for the Colonies, of Lobnitz & Co., Ltd., Renfrew, Scotland. Upon completion of the vessel, complete steam trials were carried out both for pumping and for navigation. A few hours' continuous pumping test at full power was made in which the maximum power exceeded 700 HP. and the discharge pressure on the pump exceeded 25 lbs. per sq. in. A series of speed trials were made over the measured mile in the Gareloch, which were eminently satisfactory and showed that the vessel had ample steaming and propelling power and handled easily, the speed obtained being 9 knots. After completion of these tests the vessel was made ready for sea and the open sides closed in by temporary bulkheads. The vessel was then towed to her destination and arrived without mishap of any kind in June, 1909.

Upon being finally refitted at destination a test under actual working conditions showed that the vessel was capable of pumping sand at the rate of 1,200 cu. yds. per hour (1,100 cu. yds. sand without jets, 1,300 cu. yds. with the jets). It made a cut across a sand-bar of 500 lin. ft. in 70 minutes. It is found in actual operation that when a cut has been made across a sand-bar at low water the increased flow causes an erosion so that the cut thus opened has a tendency to maintain itself in a navigable condition until the end of the low-water season.

This method of dredging has not been in use on the River Niger for sufficient length of time to determine accurately the amount of benefit that can be derived from year to year, but it is believed that the channels thus formed will not be wholly obliterated during the high water and that they can be continuously maintained from year to year with a reasonable amount of dredging, and at comparatively small expense.

A navigable depth of 5 ft. at extreme low water will be ample for the present requirements on the river and as this dredge can make a channel 12 ft. deep she can therefore begin work on the various sand-bars at a higher stage of water sufficiently in advance of the extreme low water to keep control of the river well in hand.

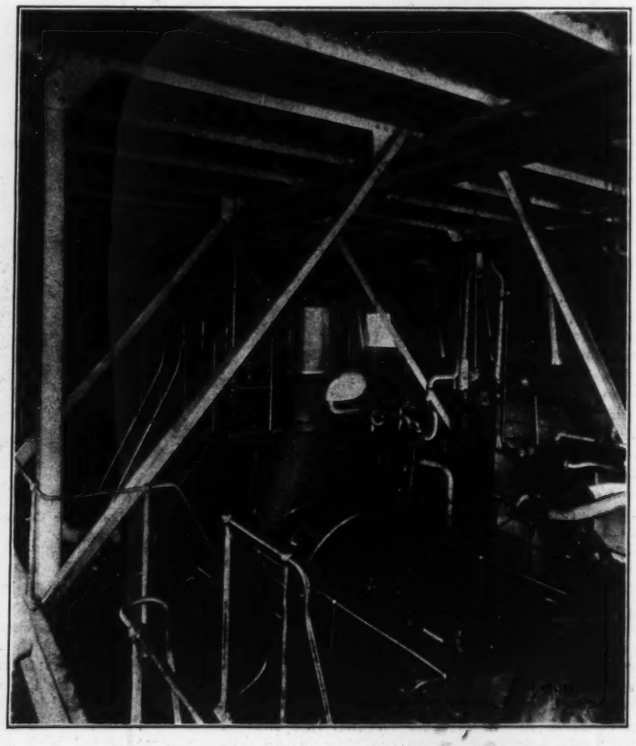


FIG. 3. PUMPING ENGINE OF THE NIGER DREDGE.

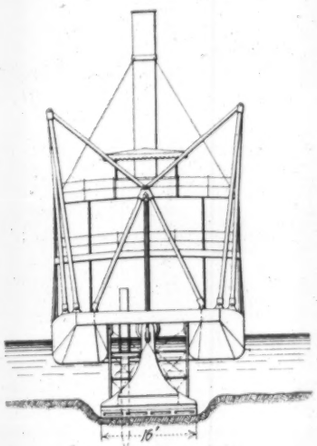
## Equilibrium Cross-Sections for Large Water-Pipes.

A matter not often thought of, whose underlying principles however often need to be carried in mind in connection with hydraulic work, was brought up by Mr. R. D. Johnson, of Niagara Falls, N. Y., in a paper* read last week before the American Society of Mechanical Engineers. He remarks that the pressure in a horizontal water-pipe is not uniform, but increases from top to bottom by an amount equal to the weight of the water in the pipe. Of course, for uniform outward pressure the circle is the equilibrium figure, and obviously a container for compressed

*"The Hydrostatic Cord," Atlantic City convention, May 31-June 3, 1910, published in the May, 1910, issue of "The Journal, American Society of Mechanical Engineers," pp. 783-787.

air would always be made to circular form. But a circle is not the equilibrium figure for such non-uniform pressure as exists in the water-pipe. The curve of equilibrium is flatter at the top, and of sharper curvature at the bottom. Mr. Johnson calls attention to such equilibrium figures, to which he gives the name "hydrostatic cord," because they are curves of cords loaded in the distribution defined by the water pressure in a pipe.

The chief features of such curves may be derived from the principle that, as the tension in a circumferential strip of the pipe must be constant throughout (since, the pressure being everywhere normal to the curve, there are no tangential components), it follows that the radius



End Elevation.

of curvature at any point must be inversely proportional to the pressure. In fact, as will be seen by considering the ring tension in a pipe subjected to *uniform* internal pressure, the tension is the product of pressure and radius of curvature, i. e.,

$$T = p\ r,$$

which equation is equally true for a short length of the circumference of the hydrostatic equilibrium curve. Now, as the tension $T$ is the same throughout the circumference, the product $p\ r$ must be constant. But the pressure varies directly as the depth of the point in question below the water surface or hydraulic grade line. Hence the radius of curvature is *inversely* proportional to this depth. Thus the curvature will be sharpest at the bottom, continually flattening toward the top, where the radius of curvature is largest.

The author states his belief that such curves should find use in the design of large pressure pipes. With the circular form the non-uniformity of the internal pressure produces bending moments in the pipe, so that the material of the wall is less efficiently utilized than if it were subjected to pure tension. By changing the pipe outline to the equilibrium curve, bending moments are eliminated, hence a considerable saving is realized.

The author appears to take no account of what would occur in such a non-circular pipe when the head varies from that assumed in the design. He would doubtless not suggest that large pipes could be designed without any regard being paid to the rigidity of the section. Obviously, too, his recommendation of the "hydrostatic cord" is not applicable to buried or partly buried pipes, where the pressures of the backfill render the load-distribution more or less indeterminate. Thus the practical bearing of his remarks is not very certain. But it must be conceded that the influence of the weight of the contents of a pipe to make the internal pressure non-uniform is often lost sight of; his article and the reflections to which it may give rise are useful in recalling this effect to the mind.

## Borings for the Panama R. R. Dock at Cristobal: With Table of Costs.

By E. B. KARNOPP.*

The Panama Railroad proposed to construct a steel and concrete dock in Cristobal at the Atlantic terminus, and an examination of the foundation was completed by means of wash drill and diamond drill borings before plans and estimates were made. The method was that used extensively on the Isthmus for the past five years, namely, of forcing a pipe line into the ground and clearing out the material with a water jet through a smaller pipe on the inside, and when the rock is encountered, the hole is continued by means of a diamond bit. The equipment used in earth, consists of a line of hollow pipe or casing 2½-ins. in diameter, in the interior of which operates a line of hollow rods 1⅞-ins. in diameter, and a tripod derrick drum and wheel attachment for hoisting same.

The tripod is made of 2 × 4-in. and 4 × 4-in. timber, with a total height of about 18 ft. A rope operating through a sheave at the top passes over a drum connected with wheel at a convenient height for the laborers and gives such a leverage that all necessary hoisting is easily done. The tripod is of light enough weight so that six men can fold it down and carry it. Canvas covers were used to protect the men during the rainy season.

The casing or hollow 2½-in. pipe is made in 5-ft. lengths with flush joints so that no projecting couplings retard its progress. The first piece to be introduced into the ground has teeth cut into the bottom and is flared out so as to give an excellent cutting edge and to make a hole slightly larger than the casing. It is revolved with chain tongs, and if its own weight is not sufficient to force it into the ground additional weight is added by men standing on the tongs. Occasionally in hard material light blows are applied to the top of the casing with an iron jar weight weighing about 100 lbs., and to prevent the casing being battered a drive head or dummy piece is first introduced.

The hollow 1⅞-in. rods are made in 5 and 10-ft. lengths. The bottom rod terminates in the chopping bit with a cutting edge similar to that of a drill bit, and as the rods are raised and dropped, or "churned," the material is broken up and is washed out to the surface by a stream of water forced down through the hollow rods and out through small holes in the chopping bit and thence to the surface up the annular ring formed between the rod and casing. The top of the rod is fitted with a water swivel of such design that rope can be hooked on and water forced through while the rods are being churned without twisting the hose. As the different materials are encountered, samples are taken by removing the chopping bit and substituting a short piece of rod open at the bottom and then driving this with a jar weight into the material, some of which is forced up into the hollow rod and is then drawn to the surface. In work where the wash drill process would be too slow to be economical, a diamond drill run by hand power was used.

For drilling holes under the water, piles were driven and staging erected thereon, and to insure the water supply for all the drills a 1¼-in. water line was connected up with the city main. Boring operations were continued for seven months, and the entire wharf line more than a mile in length was drilled with a total of 235 holes.

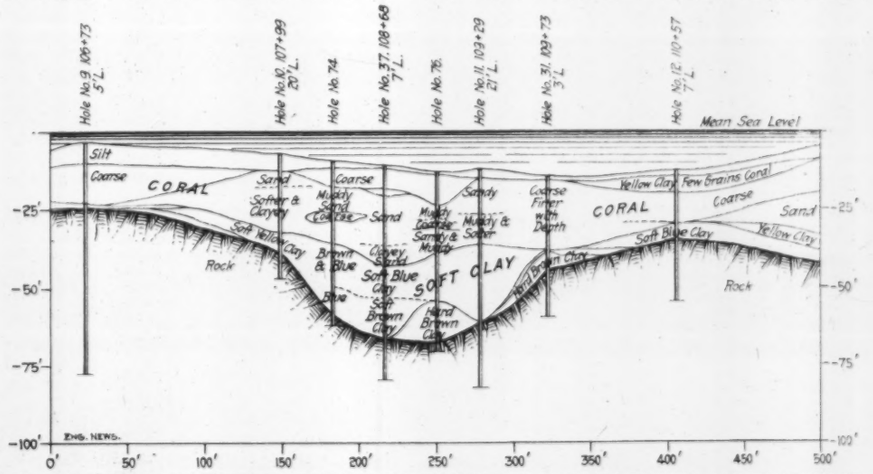
The equipment consisted of three drills, each with a white foreman and six negro laborers. An extra gang of six to ten laborers did all work of laying pipe, building staging, handling material, rodding and chaining for the recorder, supplying vacancies in the drill gang, etc. Rates of pay were:

White foreman: $150. gold per month.

Laborers: 13 to 18c. U. S. Currency per hr.

A recorder was employed throughout the whole work to keep check on the measurements of the rods and casing and to record the different materials encountered, the depth and kind of samples taken, amount and depth of core obtained and whatever other information seemed necessary. Earth samples were placed in bottles properly labelled and core samples were packed away in wooden trays. The recorder located the holes by triangulation from base line points on shore and determined the elevations of the jack planks from which all depths were measured.

A draftsman was employed to show graphically the information derived from the borings. The co-ordinates of the location of holes were computed and the locations plotted on a scale of 1 to 600. The station number and off-set from the wharf line was obtained by carefully scaling. All depths were reduced to elevations with mean sea level as zero, and the holes were plotted as a center-line profile and cross-sections. A characteristic portion of the profile is shown in the accompanying illustration. A reference table was prepared showing hole number, original boring and transit notes, location, depths, and box and tray number of samples.




CHARACTERISTIC PORTION OF CENTER-LINE PROFILE OF BORINGS FOR THE FOUNDATION OF THE PANAMA R. R. DOCKS AT CRISTOBAL.

(The material designated as rock is of the same character as that found along the Panama Canal and has been variously classified as argillaceous sandstone, young sand stone and soft blue rock.)

The following table gives total cost and amount of work done together with costs per foot:

| | | |
|---|---|---|
| 15,183.1 ft. of earth borings, at $0.587 per ft.. | $8,917.23 | |
| 1,217.1 ft. of rock borings, at $2.536 per ft.. | 3,087.42 | |
| 16,400.2 ft. Total, at average cost $.7319 per ft. | $12,004.67 | |

| | Cost per foot—Earth. | Rock. |
|---|---|---|
| Supervision and surcharge, | $0.054 | $0.227 |
| Foremen, | .107 | .449 |
| Labor drilling, | .147 | .616 |
| Extra gang and driver, | .124 | .520 |
| Drafting and recording, | .070 | .292 |
| Materials consumed, | .065 | .349 |
| Repairs, | .020 | .083 |
| Totals, | $0.587 | $2.536 |

*Assistant Engineer, Panama R. R., Cristobal, Canal Zone, Panama.

## A Long Reinforced-Concrete Railway Viaduct Through the City of Rotterdam, Holland.

An interurban electric railway line recently opened between Rotterdam, Scheveningen and the Hague, in Holland, was required by the government to enter to its station in the heart of the former city on a long viaduct, partly over the streets and property in the city and partly over open country between the city and some adjacent railway tracks, which also had to be crossed above grade. In all, the viaduct is about 5,300 ft. long and carries a two-track heavy electric railway line, so that it is among the largest of reinforced-concrete viaducts in the world. Owing to the necessities of construction in and outside of the city three or four different designs were adopted over the entire length, but in the main the system of design was uniform, and is worthy of description as an example of the latest European methods in such construction. The photographs and notes herewith were supplied us by Mr. J. B. Van Brussel, of Brussels.

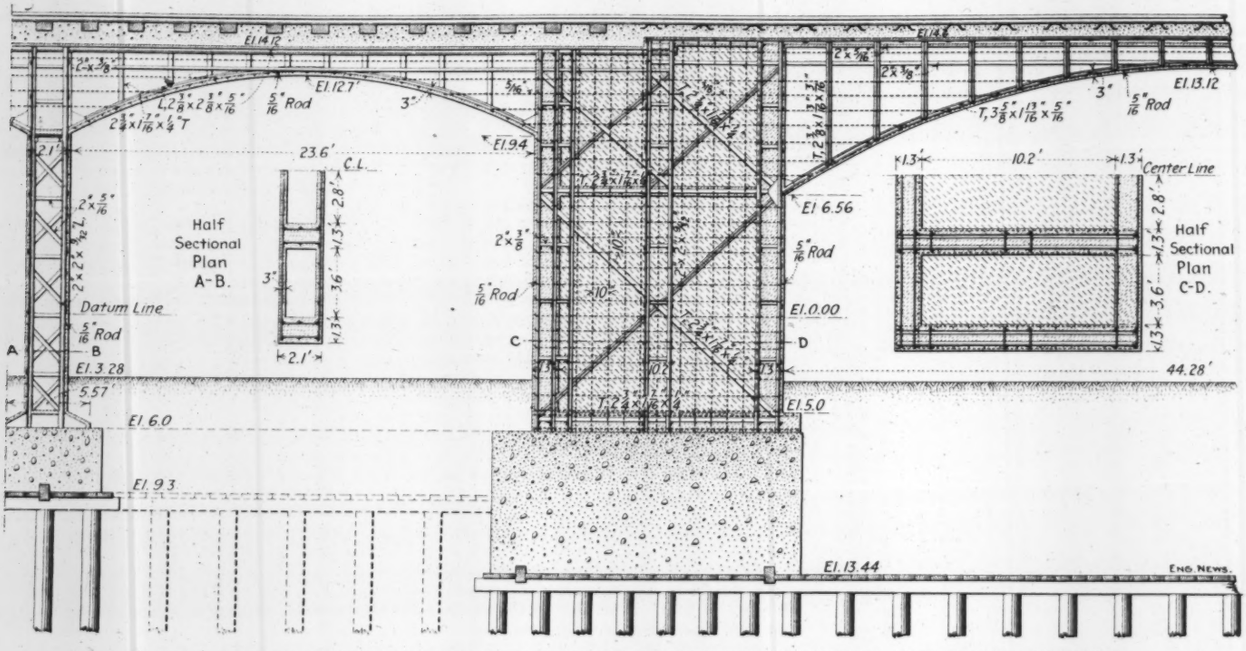



FIG. 1. DETAIL OF MAIN CITY SECTION OF REINFORCED-CONCRETE VIADUCT, ROTTERDAM, HOLLAND.

### City Portion.

The portion of the viaduct in the city proper is 2,300 ft. long and is divided into two parts, a two-track viaduct and a widened approach to the terminal station.

The viaduct proper consists of a series of 24-ft. arches on slender piers with 88-ft. arches at street crossings. A typical section is shown in Fig. 1. The foundations are concrete bases footing on wooden piles, continuous between piers. These piles have a length of from 53 to 66 ft. beneath street crossings and from 46 to 53 ft. beneath the normal spans. They support 8 × 12-in. wooden beams, 6 × 8-in. cross beams, and 3-in. flooring. Under the normal spans the upper surface of the floor is 9 ft. 5 ins. below mean water level, but at the street crossings it is placed 13 ft. 7 ins. below that level, to avoid disturbing water and other pipes of the city services. The piers rest on this plank floor, which is covered with a bed of plain concrete the upper surface of which is 6 ft. below mean water level, or 2 ft. 7 ins. below the street level.

The superstructure of the large city section comprises 63 normal spans, with 58 piers, and 6 street crossings, with 12 large piers or abutments and one middle pier. The longest crossing, that with the intermediate pier, has two spans, each of 44 ft.; the single span crossings vary in length from 33 to 72 ft. The distance between the piers of the normal spans is from 26 ft. 6 ins. to 28 ft., and these piers have a thickness of 2 ft. 2 ins.; the thickness of the bridge piers varies from 8 ft. 4 ins. to 17 ft. 8 ins., according to the length of the crossings. Each of the piers of the normal spans is composed of four rectangular columns (Fig. 1) of reinforced concrete, 18 ft. 3 ins. high, 1 ft. 6 ins. wide and 2 ft. 2 ins. thick, connected together by two walls, each 3 ins. thick, and further by a common base of reinforced concrete, which distributes the weight over a large surface of the plain concrete foundation.

These four columns support the four arched girders, which are 12 ins. wide, 18 ins. deep in the middle and 58 ins. deep at the ends and reinforced with structural shapes (Fig. 2). Each girder lies vertically under a rail of the double track. The concave lower surfaces of the four girders of the span are connected together by a sheet of reinforced concrete 3 ins. thick, which is joined to the walls which flank the columns. The flat upper surfaces of the girders are connected by a concrete floor, of an average thickness of 5 ins., which supports the ballast and track.

The floor is constructed by first laying, as forms, concrete tiles 1 3-5 ins. thick, which are just strong enough to support the concrete floor slab until it sets. The floor overhangs on each side the exterior girders by 30 ins. and carries a raised footway 36 ins. wide. The trough, 22 ft. 3 ins. wide and 14 ins. deep, between the footways is filled with crushed stone in which the wooden cross-ties are embedded. The ties are 6 ins. deep and rest upon an 8-in. stratum of ballast.

The street crossings are constructed on the same plan as the normal spans. The arched girders, though they have the same width and the same depth at the middle as the shorter gir-

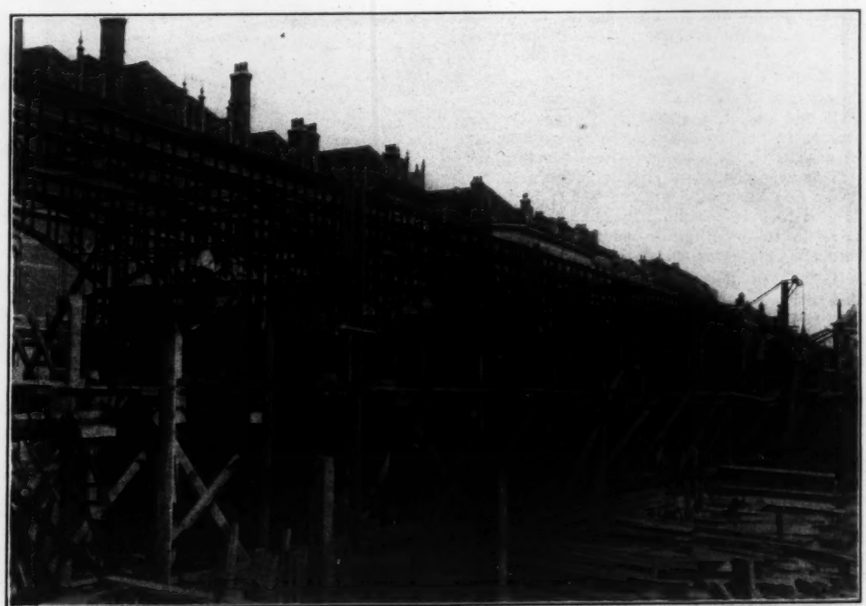


FIG. 2. VIEW OF NORMAL 24-FT. SPANS IN CITY SECTION DURING CONSTRUCTION.
(Note Structural Shape Reinforcement.)

ders of the normal spans, are 98 ins. deep at the ends. This increase in the depth of the girders necessitates the employment of iron cross-ties, in order to maintain the depth of ballast beneath the ties at 8 ins.

The piers of the street crossings are composed of four longitudinal 16-in. walls, connected by two transverse walls of the same thickness and by a base 14 ins. thick, which equalizes the pressure on the plain concrete foundation. In order to equalize the pressures on the four walls, they are connected, at the top, by a floor-slab of reinforced concrete. The voids between the walls are filled with a weak, non-reinforced concrete, which by its weight increases the stability of the structure. The reinforcement of most of this section of the viaduct consists of round, flat and small angle or T-bars.

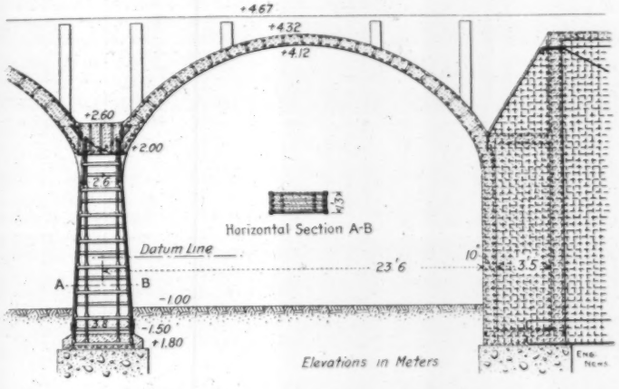



FIG. 3. DETAIL OF SOLID ARCH CONSTRUCTION AT TERMINUS.

The terminus section is an enlarged continuation of the normal city section. The width of this section increases from 26 ft. 8 ins. to 153 ft. In this part of the viaduct the irregular distribution of the tracks made it necessary to change the method of construction. Here the roadbed rests upon solid arches, each 8 ins. thick in the middle and 12 ins. thick at the edges (Fig. 3). The arches abut on reinforced-concrete beams, 24 × 32 ins. in section, spanning columns measuring 16 × 32 ins. at the top and 16 × 46 ins. at the base. The edges of the columns are reinforced with 2 × 2 × ¼-in. angle iron. The columns are connected by a base of reinforced concrete 5 ft. wide and 1 ft. deep. The number of columns under each beam varies with the width of the viaduct, but the maximum distance between consecutive columns does not exceed 6 ft.

### Extraurban Portion.

The section of the viaduct between the city and the junction line includes 79 normal spans, 6 street crossings, 3 aqueduct crossings and the junction or final abutment. The normal spans resemble those of the city section (Fig. 5) but the four columns of each pier rise from a reinforced-concrete girder having a cross-section in the form of an inverted T, with a base 8 ft. wide, 28 ins. thick at the middle and 20 ins. thick at the edges. Only flat and round iron are used for reinforcing. The girder rests on 22 piles, the heads being surrounded by spirals of round iron embedded in the concrete. The foundation girders at the two ends of the span are connected by four longitudinal girders 14 ins. wide and 51 ins. deep, and these are connected by an intermediate transverse girder of the same dimensions, forming a strong and rigid foundation. The street crossings only differ little from those of the city sections. The massive piers of street crossings serve not only to support the long bridge spans but also to resist longitudinal stresses caused by an unequal contraction such as starting and stopping of trains. Hence in the section outside the city, where street crossings are far apart, it has been deemed necessary to replace, in some of the normal spans, the longitudinal girders at the top and bottom of the columns by 12-in. walls, extending from the heads of the piles to the floor supporting the roadbed, and to connect these walls at the bottom by a bed of reinforced concrete, 20 ins. deep and extending 8 ins. below the top of the piles. The longitudinal walls are connected also by a 6-in. front and rear walls.

Two of the three water conduits were small enough to be included within normal spans, but as it was necessary to omit the longitudinal girders connecting the bases of the columns, the discontinuity in the foundations thus caused was compensated by the construction of four thick longitudinal walls resting on bases similar to those used beneath the columns. These walls are connected by 6-in. front and rear walls and by a 4-in. floor, which covers the water conduit. The third water conduit is crossed by the method adopted for street crossings.

The city portion of the line passes directly through both residence and business sections, crossing city blocks but not following street lines. In consequence of the extremely light piers only a small ground space is occupied and the property beneath the arches is utilized for warehouses and other low buildings.

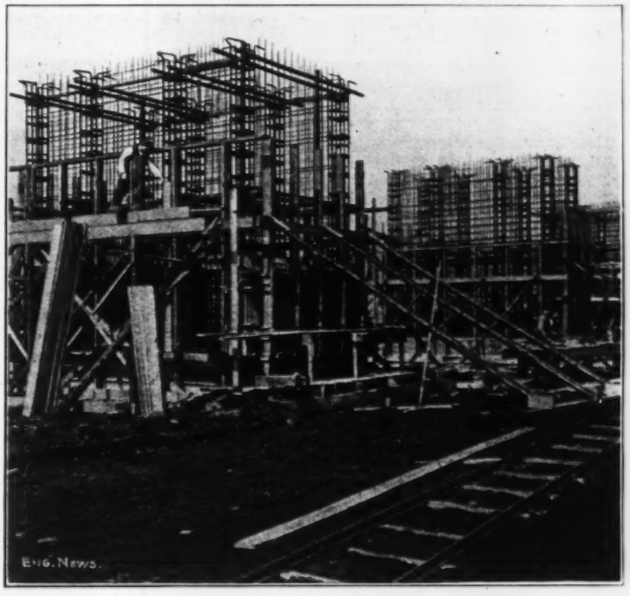



FIG. 6. VIEW OF PIERS UNDER CONSTRUCTION IN BEYOND-CITY PORTION OF REINFORCED-CONCRETE VIADUCT, ROTTERDAM, HOLLAND.

## A Novel Test for Resistance to Corrosion.

It is notably difficult to determine the comparative protecting power of different paints for metal, and equally difficult to measure the relative rapidity of corrosion of two samples of metal. Yet the structural engineer and especially the railway engineer—constantly has the problem of choosing between different paints or between different metals which are exposed to rusting. Mr. Hunter McDonald, Chief Engineer of the Nashville, Chattanooga & St. Louis Ry., therefore devised a simple though severe test for rust-resistance, some eight or ten years ago, and has since then used it extensively in the service of his road.

Mr. McDonald describes his test as follows:

The test is designed to reproduce, as accurately as pos-

FIG. 4. VIEW DURING CONSTRUCTION OF SOLID ARCH CONSTRUCTION AT TERMINUS.

sible, the conditions under which the paint is tested in actual practice. Disks 6 ins. in diameter are cut from metal about No. 22 gage, and hammered into saucers having a depth of about ¾-in. These are painted with the paint to be tested, and after being thoroughly dry they are placed on a window-ledge with southern exposure, filled about two-thirds full of locomotive stack cinders from bituminous coal. They are then filled with water and as the water evaporates are refilled.

The results of some of the paint tests made by this method have been published in the Proceedings of the Engineering Association of the South.

Recently Mr. McDonald has also used the method for testing sheet-metal for relative rapidity of rusting. Such testing is especially necessary because of the sharp discussions in recent times over the relative durability of wrought-iron sheet and steel sheet, and the still more recent development of special irons for which great resistance to rusting is claimed, for example, the "American Ingot Iron," whose production was described at some length in our issue of Jan. 6, 1910. Some of this latter material, in fact, was tested by Mr. McDonald. It is the practice on the N. C. & St. L. Ry. to cover the tops of cap and stringer timbers in trestles with sheet-metal, as a protection against fire and water; for this service a metal of maximum durability is desired, to minimize the expensive renewals. While galvanized steel and charcoal iron are chiefly used, a considerable amount of "American Ingot Iron" has been applied, and in time the actual service will give a practical comparison of the durability of these metals. In the meantime some accelerated corrosion tests was carried out, including an ordinary acid test and a sauce test as above described.

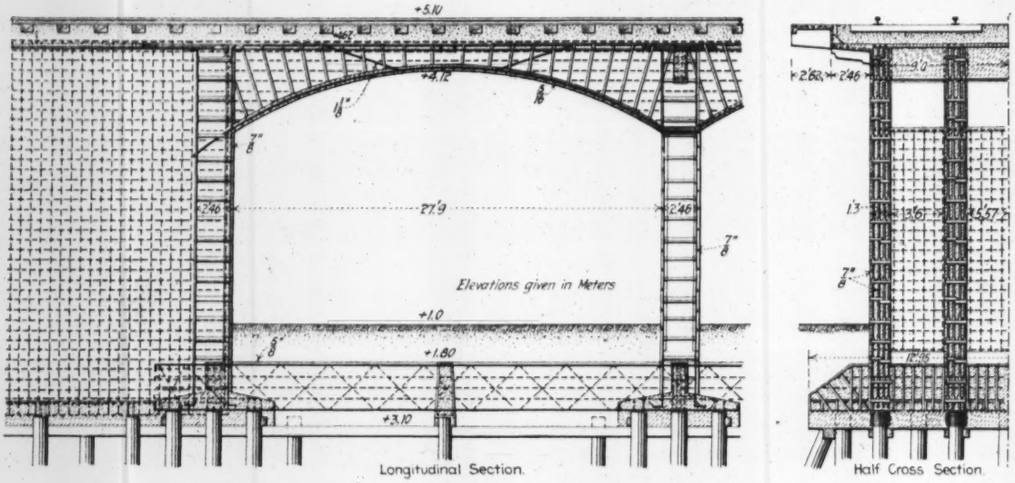



FIG. 5. DETAIL OF NORMAL SPAN IN PORTION OF ROTTERDAM VIADUCT BEYOND THE CITY.

The sheet-metal for these tests was originally galvanized. After disks were cut from it, they were placed in a hot coke fire to burn off the zinc. The weights before and after, showing by difference, the weight of the zinc coating, were compared with the weight of zinc found by dissolving by acid, and the comparison indicated that possibly the fire did not burn off all the zinc, which may have affected the subsequent corrosion test. The acid solution test indicated that the charcoal iron and the "Ingot Iron" sheets originally had about equal weight of zinc coating, while the steel sheet had a slightly heavier coating. All three samples, however, resisted the copper-sulphate immersion test equally well, five immersions being required before any of them showed copper deposition.

A sulphuric acid test of the samples was made, according to the method recommended by the American Society for Testing Materials. One sample of each material was tested with galvanizing removed (by acid) and one with galvanizing left on. The galvanized samples showed up almost alike; the black samples showed the order of merit to be: "Ingot Iron," charcoal iron, steel. It is remarkable that the loss of weight was very much greater for the galvanized than for the black samples. The results are given below in tabular form.

At the same time a saucer test by Mr. McDonald's method was begun. This continued for several months, with the result that the "Ingot Iron" and the steel were in fairly good shape, and about equal, whereas the charcoal iron saucer was totally destroyed. This surprising result does not check with that of the acid test, which may be chargeable either to the different conditions of the tests or to imperfect removal of the zinc by the fire. At any rate, comparison of the two tests again suggests the well-known fact that corrosion tests display more variability and uncertainties than most other tests, and require a long series to give a useful average.

An interesting point was brought out when the saucer test was applied to some corrugated galvanized sheet. A concave section was cut from a corrugated culvert pipe, the ends bent up to hold water, and the procedure of the saucer test gone through. It was found that rust soon appeared at the top and bottom of the corrugations, suggesting the conclusion that the zinc coating was cracked at the bends in the corrugating machine, and therefore had little protective value left.

CORROSION TESTS OF IRON AND STEEL.

| | Sulphuric acid test. Loss of weight, per cent. | Saucer test. |
|---|---|---|
| "AMERICAN INGOT IRON." | | |
| Galvanized | 9.25 | ..... |
| Galv. removed: by acid | 0.10 | ..... |
| by fire | .... | Slight fitting |
| CHARCOAL IRON. | | |
| Galvanized | 12.36 | Broke up into thin layers. |
| Galv. removed: by acid | 0.34 | ..... |
| by fire | .... | Badly corroded, practically destroyed. |
| STEEL. | | |
| Galvanized | 9.22 | ..... |
| Galv. removed: by acid | 4.35 | ..... |
| by fire | .... | Slight pitting. |

Note: The samples in the acid test were 2 × 1 × 1/32-in. The samples in the saucer test were disks about 6 ins. diam.

ALLEGED FRAUDS IN CAR REPAIR WORK are the grounds for a suit just started by the Illinois Central R. R. against four former officers. According to press reports from Chicago, the company asks an accounting of the following: O. S. Keith, until recently Superintendent of Transportation; J. E. Buker, Superintendent of Car Department; W. Renshaw, Assistant Superintendent of Machinery, and J. M. Taylor, General Storekeeper; and of the West Pullman Car Co. and the American Car & Equipment Co. Three other firms are said to be involved in overcharges through collusion with the officers named. It is asserted by the railroad company that beginning in 1906 the four officers caused car-repair work to be done at the shops of certain companies in which they were interested, on the claim that the railroad could not do the work as cheaply itself; that large overcharges were made thereafter; that materials belonging to the railroad were turned over to the repairing concerns without payment; and that the officers concerned profited largely thereby. An aggregate amount of $2,000,000 has been named as the loss to the railroad company.

## Records of Evaporation Obtained at 23 Different Stations in Various Parts of the United States.

The need of accurate records of evaporation is felt by engineers engaged in many branches of hydraulic engineering. For some time past various bureaus of the U. S. Government have been cooperating in evaporation observations. Through the courtesy of Prof. Frank H. Bigelow, Professor of Meteorology, in charge of the Climatological Division of the U. S. Weather Bureau, we have been furnished with an advance summary of the data thus far gathered in this field, which is shortly to be issued in the Bureau as "Abstract of data, No. 4." We print the summary in full as follows:

In view of the interest in the general results of the work on evaporation, conducted by the United States Weather Bureau in 1909-10, it is thought proper to issue a provisional statement regarding the total amount of evaporation by months that has been measured at the several stations of the United States Weather Bureau, the United States Reclamation Service, and the United States Geological Survey.

It has been necessary to make interpolations at some of the stations where our records are not yet complete, as at the Salton Sea where the year will not be concluded before June 15, and at other stations where observations were not continued during the winter months. It was found by plotting down the curves, as far as available, that it was quite practicable to complete the curves approximately, and read off the corresponding amounts of evaporation for the missing months. Such interpolations are shown by italic type in the accompanying tables. At each station it is indicated, approximately, where the pan was located, as "on the ground," 2 ft., 10 ft., or 20 ft. above the ground; and the diameter of the pan is stated as

$D = 2$; $D = 3$; $D = 4$; $D = 6$ ft., respectively.

### Description of Stations.

STATION NO. 1, SALTON SEA, CAL., TOWER NO. 1.—This tower is located about 1,500 ft. inland, and perhaps 30 or 40 ft. above the level of the sea, Pan No. 1 being on the ground, and Pan No. 5 being elevated about 40 ft.

STATION NO. 2, SALTON SEA, TOWER NO. 2.—This tower is located near the trestle of the Southern Pacific Railroad, about 500 ft. from the shore. Pan No. 1 hangs on a frame suspended from the tower about 2 ft. above the water surface. The automatic record indicates that the sea has fallen about 4.60 ft. annually, or, allowing for the inflow, we have a little more or less than 6.0 ft. by evaporation. It is probable that the inflow from the New and Alamo rivers, together with the precipitation flowing in from the surrounding country amounts to something like 1.5 ft. Pans of different sizes evaporate at different rates. A pan of 2 ft. in diameter is represented, approximately, by the coefficient about 0.042; a pan of 4 ft. in diameter by the coefficient 0.036; and a pan of 6 ft. in diameter by the coefficient 0.031. It is not now known what corresponding coefficient should be adopted for the large water surface which represents a pan of great diameter, as a lake, and this is really the most difficult part of the problem to determine. This coefficient is probably between 0.023 and 0.025. The formula is

$$E_0 = C_2 \frac{e_s}{e_d} \frac{de}{dS} (1 + .070w).$$

$E_0$ = the evaporation in 4 hrs.
$e_s$ = the vapor pressure at the water temperature.
$e_d$ = the vapor pressure at the dew-point temperature.
$\frac{de}{dS}$ = the coefficient from the physical table.
$w$ = the wind velocity in kilometers per hour.

STATION NO. 3, SALTON SEA, TOWER NO. 4.—This tower is located about 1½ miles west of the trestle and stands in something like 50 ft. of water, so that it receives the full effects of the wind and water influences. The differences in evaporation between Towers Nos. 2 and 4 are very small.

STATION NO. 4, INDIO, CAL., is located at the Government Date Farm about 2 miles from the railroad station, and 15 miles north of the Salton Sea, in the midst of an alfalfa patch. The great differences between the evaporation at the upper and lower pans is in part due to the size of the pans, but especially to the fact that the lower pan was much sheltered from the wind effect by the surrounding alfalfa growth.

STATION NO. 5, MECCA, CAL., is located near the railroad station, half a mile north of the Salton Sea, in an ordinary place, with trees and an occasional grass plot in the neighborhood.

STATION NO. 6, BRAWLEY, CAL., is located about 20 miles south of the Salton Sea, in an irrigated district between the New and Alamo rivers.

STATION NO. 7, MAMMOTH, CAL., is located on the main line of the Southern Pacific Railroad, about 40 miles southeast of the Salton Sea in the midst of the desert, the great sand dunes being in that neighborhood.

STATION NO. 8, NORTH YAKIMA, WASH., is located about a mile west of the city of North Yakima, on the United States reclamation project.

STATION NO. 9, HERMISTON, ORE., is located at the reservoir of the Umatilla Project, Pan No. 1 being on the raft, Pan No. 2 on a 10-ft. stand, and Pan No. 3 on the bridge leading to the tower.

STATION NO. 10, GRANITE REEF DAM, ARIZ., is located on the Salt River, about 20 miles from Phoenix, Pan No. 1 being on the ground, Pan No. 2 on a 10-ft. stand, and Pan No. 3 floating in the river.

STATION NO. 11, CALIFORNIA, OHIO, is located about 8 miles east of the city of Cincinnati at the filtration water-works, Pan No. 1 being floated in one of the reservoirs, and Pan No. 2 on a concrete dike separating two of the reservoirs.

STATION NO. 12, BIRMINGHAM, ALA., is located at the East Lake Park, Pan No. 1 being floated in the water within a raft which was anchored in the middle of the Lake; Pan No. 2 was suspended 10 ft. above Pan No. 1; Pan No. 3 was floated in the water near the western edge of the lake; Pan No. 4 was suspended 10 ft. above it; Pan No. 5 was located on the tower of the chute about 20 ft. above the water, and Pan No. 6 was 40 ft. above the water.

STATION NO. 13, DUTCH FLATS STATION, NEB., is located a few miles from Mitchell in the Inter-State Project, Pan No. 1 being on the ground and Pan No. 2 on a 10-ft. stand.

STATION NO. 14, MINIDOKA DAM, IDAHO, is about 8 miles from Rupert, on the Snake River, and the pan was located in the backwater just east of the dam.

STATION NO. 15, DEER FLAT, is located on the Payette-Boise Project, Idaho, and consisted of 2 towers, Pan No. 1 being on the ground of the embankment near the dam, and Pan No. 2 on a tower 20 ft. high. Pan No. 3 was on a raft near the edge of the water, and Pan No. 4 on a tower about 20 ft. high. Pan No. 3 was moved to follow the recession of the water and kept as near the edge of it as practicable.

STATION NO. 16, LAKE KACHESS, WASH., is located a few miles north of North Yakima, and consists of a pan on a 10-ft. stand.

STATION NO. 17, ADY, ORE., is located at the Marsh Farm on the Klamath Project. The station had one pan floating in the borrow pit of the railroad. Pan No. 2 was on a tower placed in the tules 10 ft. from the ground, and stood just above the tops of the tules. Pan No. 3 was 20 ft. above the ground.

STATION NO. 18, FALLON, NEV., is located on the Truckee-Carson Project and had one pan floating in the canal near the headquarters, and a second pan was on a 10-ft. stand.

STATION NO. 19, LAKE TAHOE, CAL., is 6,200 ft. above sea level. During July and August the station was located near the Tahoe Tavern railroad wharf, one pan being 2 ft. above the water and a second pan 10 ft. above the water. These pans were moved to Tahoe City, near the outlet of the Truckee River, and located on the end of Bliss's wharf.

STATION NO. 20, ELEPHANT BUTTE, N. MEX., is located about 10 miles from Engle, near the proposed dam over the Rio Grande, the station being at the United States reclamation project. One pan was on the ground and a second pan on a 10-ft. stand.

STATIONS NOS. 21 AND 22, CARLSBAD, N. MEX.—The first station was at the Government Building, one pan being on the ground, and a second pan on a 10-ft. stand. The second station was in an alfalfa field about half a mile south of the town, one pan being on the ground and another on a 10-ft. stand.

STATION NO. 23, LAKE AVALON, N. MEX., a few miles north of Carlsbad, had one floating pan and one pan on a 10-ft. stand.

The figures contained in these tables have not been corrected for the wind effect, the temperature effect, the vapor pressure effect, nor for the size of the pans, and they represent the observed evaporation at the pan as located.

Referring to the Salton Sea, note 193 ins. on the top of Tower No. 1, and 164 ins. at the bottom of it; 138 ins. at the top of Tower No. 2, and 109 ins. within 2 ft. of the water surface; 140 ins. at the top of Tower No. 4 and 106 ins. at the lower suspended pan.

These data indicate a nearly uniform rate of evaporation over the area of the water, beginning a short distance from the shore. If 70 ins. is admitted as the amount evaporated from the Salton Sea, there remains 38 ins. as the difference between the water in the sea and that in the lower swinging pan. It was not possible to float pans in the waves of the Salton Sea, and it is not easy to take the step in the research just indicated in order to arrive at the true coefficient for the water of the Salton Sea. Our computations on the temperatures are not yet completed regarding this point, and we are conducting another experiment with a series of pans, 2 ft., 4 ft., 6 ft. and 12 ft. in diameter. By computing with the formula, assuming values of $C_2 = .021, .023, .025, .027, .029$, and using the observed temperatures of the Salton Sea surface water, it is now probable that the coefficient for a large water surface is $C_2 = .024$.

TOTAL AMOUNT OF EVAPORATION BY MONTHS.

| Number | 1. | | 2. | | 3. | | 4. | | 5. | |
|---|---|---|---|---|---|---|---|---|---|---|
| Station | Salton Sea, Tower No. 1, 1,500 ft. inland. | | Salton Sea, Tower No. 2, 500 ft. at sea. | | Salton Sea, Tower No. 4, 7,500 ft. at sea. | | Indio, Cal. 10-foot stand. | | Mecca, Cal. 10-foot stand. | |
| Position of pans | (1) Ground. D=4. | (5) 40 feet. D=2. | (1) 2 feet. D=4. | (5) 45 feet. D=4. | (1) 2 feet. D=4. | (5) 45 feet. D=4. | (1) Ground. D=6. | (2) 10 feet. D=2. | (1) Ground. D=6. | (2) 10 feet. D=2. |
| January | 5.08 | 7.05 | 3.61 | 5.14 | 3.41 | 4.69 | 3.18 | 5.52 | 2.92 | 5.46 |
| February | 7.42 | 9.45 | 5.01 | 7.17 | 5.09 | 7.40 | 5.08 | 8.83 | 5.09 | 8.75 |
| March | 12.50 | 13.85 | 6.75 | 9.00 | 6.95 | 9.50 | 7.50 | 12.09 | 8.07 | 11.87 |
| April | 15.75 | 17.85 | 9.00 | 10.60 | 8.75 | 11.80 | 12.05 | 19.17 | 10.87 | 16.96 |
| May | 19.00 | 20.60 | 11.00 | 13.00 | 10.60 | 14.00 | 15.84 | 25.13 | 12.72 | 21.26 |
| June | 21.50 | 23.50 | 13.50 | 16.75 | 13.00 | 16.75 | 16.11 | 26.69 | 14.23 | 21.56 |
| July | 22.15 | 24.96 | 14.77 | 18.63 | 14.03 | 17.98 | 16.34 | 27.24 | 15.21 | 22.59 |
| August | 18.50 | 21.21 | 12.63 | 15.02 | 12.19 | 15.33 | 13.78 | 23.05 | 13.22 | 20.41 |
| September | 15.50 | 19.47 | 12.40 | 15.18 | 12.06 | 15.40 | 12.37 | 21.13 | 10.29 | 16.96 |
| October | 13.19 | 17.29 | 9.20 | 12.21 | 9.24 | 13.02 | 8.91 | 16.85 | 8.17 | 12.43 |
| November | 7.49 | 10.05 | 6.21 | 8.13 | 5.96 | 7.48 | 5.17 | 9.44 | 4.13 | 7.15 |
| December | 6.42 | 9.55 | 4.67 | 6.97 | 5.25 | 6.97 | 3.00 | 5.25 | 2.98 | 4.65 |
| Year | 164.50 | 193.44 | 108.65 | 137.71 | 106.45 | 140.02 | 119.33 | 200.39 | 107.91 | 169.95 |

| Number | 6. | | 7. | | 8. | | 9. | | |
|---|---|---|---|---|---|---|---|---|---|
| Station | Brawley, Cal. 10-foot stand. | | Mammoth, Cal. 10-foot stand. | | N. Yakima, Wash. 10-foot stand. | | Hermiston, Oreg. Raft, stand, bridge. | | |
| Position of pans | (1) Ground. D=6. | (2) 10 feet. D=2. | (1) Ground. D=6. | (2) 10 feet. D=2. | (1) Ground. D=4. | (2) 10 feet. D=2. | (1) Raft. D=4. | (2) Ground. D=4. | (3) 25 to 65 D=2. |
| January | 3.05 | 5.32 | 4.24 | 6.47 | 1.75 | 2.00 | 1.85 | 1.80 | 2.00 |
| February | 5.00 | 8.00 | 5.57 | 8.89 | 2.50 | 4.25 | 1.85 | 1.75 | 2.25 |
| March | 8.00 | 11.00 | 8.99 | 11.65 | 6.25 | 8.25 | 2.00 | 4.25 | 5.50 |
| April | 10.74 | 16.04 | 12.02 | 17.13 | 7.91 | 9.90 | 7.28 | 9.28 | 9.39 |
| May | 13.79 | 21.57 | 15.52 | 22.00 | 8.36 | 10.16 | 7.89 | 11.38 | 10.87 |
| June | 13.68 | 20.21 | 16.75 | 24.17 | 8.90 | 11.13 | 9.54 | 13.44 | 13.47 |
| July | 14.14 | 20.96 | 18.00 | 25.68 | 10.74 | 12.51 | 12.04 | 17.48 | 17.27 |
| August | 11.26 | 21.18 | 13.73 | 18.15 | 9.41 | 11.63 | 11.07 | 16.89 | 16.00 |
| September | 10.15 | 16.30 | 12.16 | 17.04 | 5.51 | 7.81 | 7.35 | 10.09 | 10.55 |
| October | 6.99 | 11.58 | 9.49 | 14.72 | 3.15 | 3.98 | 3.58 | 6.00 | 7.31 |
| November | 4.09 | 7.01 | 5.26 | 8.08 | 2.00 | 2.50 | 2.00 | 3.00 | 4.00 |
| December | 2.66 | 4.57 | 3.70 | 5.12 | 1.50 | 2.00 | 1.50 | 1.75 | 2.50 |
| Year | 103.55 | 163.74 | 125.53 | 179.10 | 67.96 | 86.12 | 68.05 | 97.29 | 101.11 |

| Number | 10. | | | 11. | | 12. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Granite Reef, Ariz. Salt River. 10-foot stand and float. | | | California, O. Filtration plant. Float and stand. | | Birmingham, Ala. East Lake reservoir. Floats and stands. | | | | | |
| Position of pans | (1) Ground. D=4. | (2) 10 feet. D=2. | (3) Floating. D=4. | (1) Floating. D=4. | (2) 10 feet. D=3. | (1) Floating. D=4. | (2) 10 feet. D=2. | (3) Floating. D=4. | (4) 10 feet. D=2. | (5) 20 feet. D=2. | (6) 40 feet. D=2. |
| January | 4.59 | 5.28 | 4.85 | 1.00 | 1.25 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| February | 4.75 | 6.50 | 4.40 | 1.50 | 2.00 | 1.50 | 1.75 | 1.50 | 1.75 | 1.75 | 1.75 |
| March | 6.25 | 7.25 | 6.25 | 2.50 | 3.50 | 2.25 | 2.50 | 2.25 | 2.50 | 2.50 | 2.50 |
| April | 9.00 | 10.50 | 7.00 | 4.12 | 6.50 | 4.45 | 6.64 | 5.36 | 6.55 | 6.93 | 7.11 |
| May | 11.50 | 13.40 | 9.50 | 5.07 | 7.69 | 5.91 | 7.41 | 6.36 | 7.57 | 7.68 | 7.84 |
| June | 13.50 | 15.50 | 12.00 | 6.21 | 8.28 | 7.28 | 8.63 | 7.54 | 8.66 | 8.88 | 8.98 |
| July | 14.45 | 16.55 | 12.75 | 7.20 | 9.74 | 7.36 | 9.42 | 6.96 | 9.59 | 9.76 | 10.25 |
| August | 14.23 | 16.43 | 12.50 | 7.28 | 8.88 | 7.34 | 9.45 | 7.32 | 10.39 | 10.57 | 11.03 |
| September | 13.76 | 16.66 | 11.00 | 5.63 | 6.66 | 6.00 | 7.46 | 5.59 | 7.11 | 8.87 | 8.94 |
| October | 11.31 | 14.22 | 8.31 | 3.00 | 4.00 | 4.00 | 5.00 | 4.00 | 5.00 | 6.00 | 5.00 |
| November | 7.39 | 9.84 | 6.56 | 1.50 | 2.00 | 2.25 | 2.75 | 2.25 | 2.75 | 2.75 | 2.75 |
| December | 4.65 | 5.61 | 4.22 | 1.00 | 1.25 | 1.50 | 1.75 | 1.50 | 1.75 | 1.75 | 1.75 |
| Year | 115.18 | 136.84 | 97.74 | 45.99 | 61.83 | 51.34 | 64.26 | 52.13 | 65.22 | 66.24 | 69.40 |

| Number | 13. | 14. | 15. | | | | 16. | 17. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Station | Dutch Flats, Nebr. Interstate Canal. 10-foot stand. | Minidoka Dam, Idaho. Snake River. 10-foot stand. | Deer Flat, Idaho. Payette-Boise. | | | | Lake Kachess, Wash. Yakima River. 10-foot stand. | Ady, Klamath, Oreg. Float and 20-foot stand. | | |
| | | | Tower A. | | Tower B. | | | | | |
| Position of pans | (1) Ground. D=4. | (2) 10 feet. D=3. | (1) 10 feet. D=3. | (1) Ground. D=3. | (2) 20 feet. D=3. | (3) Raft. D=4. | (4) 20 feet. D=4. | (1) 10 feet. D=3. | (1) Floating. D=4. | (2) 10 feet. D=3. | (3) 20 feet. D=3. |
| January | 1.75 | 2.00 | 2.25 | 1.50 | 1.75 | 2.00 | 2.00 | 0.50 | 0.50 | 1.00 | 1.00 |
| February | 1.75 | 2.25 | 2.50 | 2.25 | 2.50 | 2.75 | 3.00 | 0.50 | 1.25 | 1.75 | 2.00 |
| March | 2.00 | 3.50 | 4.00 | 4.00 | 5.40 | 4.25 | 4.50 | 1.25 | 3.57 | 4.81 | 5.00 |
| April | 4.50 | 6.00 | 7.00 | 7.25 | 9.50 | 6.00 | 7.00 | 2.57 | 6.64 | 8.25 | 8.77 |
| May | 6.25 | 8.50 | 11.21 | 10.08 | 11.84 | 7.90 | 9.50 | 3.83 | 7.15 | 9.10 | 9.84 |
| June | 8.05 | 10.97 | 12.31 | 11.05 | 11.97 | 9.59 | 10.80 | 5.54 | 6.99 | 10.04 | 11.32 |
| July | 10.95 | 14.67 | 15.00 | 11.15 | 11.70 | 10.59 | 12.50 | 5.93 | 8.01 | 11.10 | 11.99 |
| August | 9.20 | 12.66 | 13.50 | 11.77 | 11.54 | 12.16 | 12.48 | 5.31 | 9.21 | 12.35 | 13.26 |
| September | 7.44 | 9.96 | 11.00 | 9.75 | 10.50 | 9.25 | 10.50 | 4.41 | 8.13 | 8.98 | 7.91 |
| October | 5.59 | 7.62 | 8.50 | 5.40 | 5.05 | 5.42 | 5.82 | 1.47 | 2.50 | 4.67 | 5.04 |
| November | 4.00 | 5.25 | 5.75 | 2.70 | 4.25 | 3.52 | 3.62 | 0.75 | 1.00 | 2.80 | 2.82 |
| December | 2.00 | 2.60 | 2.80 | 1.50 | 1.75 | 2.00 | 2.00 | 0.50 | 0.50 | 1.25 | 1.50 |
| Year | 65.67 | 86.38 | 96.52 | 79.40 | 87.85 | 77.43 | 84.08 | 32.76 | 53.45 | 74.10 | 80.35 |

| Number | 18. | 19. | 20. | 21. | 22. | 23. |
|---|---|---|---|---|---|---|
| Station | Fallon, Nev. Truckee-Carson. 10-foot stand. | Lake Tahoe, Cal. 10-foot stand. | Elephant Butte, N. Mex. Rio Grande. 10-foot stand. | Carlsbad, N. Mex. At Reclamation office. 10-foot stand. | Alfalfa field, near Carlsbad. 10-foot stand. | Lake Avalon, Pecos River. 10-foot stand. |
| Position of pans | (1) Floating. D=4. | (2) 10 feet. D=3. | (1) 2 feet. D=4. | (2) 10 feet. D=3. | (1) Ground. D=4. | (2) 10 feet. D=3. | (1) Ground. D=4. | (2) 10 feet. D=3. | (1) Floating. D=4. | (2) 10 feet. D=3. |
| January | 1.75 | 2.00 | 1.75 | 1.75 | 2.50 | 2.75 | 5.00 | 6.00 | 5.00 | 6.50 | 4.50 | 6.50 |
| February | 1.75 | 2.25 | 1.75 | 1.75 | 2.75 | 3.00 | 5.50 | 7.00 | 5.25 | 7.00 | 4.50 | 7.00 |
| March | 2.25 | 3.00 | 1.75 | 1.75 | 4.50 | 5.75 | 8.94 | 9.85 | 6.85 | 10.50 | 5.51 | 8.87 |
| April | 3.25 | 4.50 | 2.00 | 2.25 | 6.00 | 10.25 | 11.68 | 12.40 | 11.09 | 13.05 | 7.45 | 13.83 |
| May | 5.25 | 7.50 | 3.00 | 3.50 | 11.50 | 14.75 | 12.96 | 13.79 | 10.95 | 16.41 | 10.12 | 13.72 |
| June | 7.96 | 12.97 | 4.25 | 5.00 | 13.45 | 16.53 | 12.40 | 13.49 | 9.06 | 14.72 | 11.05 | 18.41 |
| July | 9.56 | 15.84 | 6.19 | 6.49 | 11.57 | 13.66 | 12.00 | 12.99 | 10.56 | 14.47 | 12.38 | 17.90 |
| August | 8.70 | 14.25 | 7.08 | 7.42 | 10.48 | 12.34 | 11.03 | 10.84 | 9.32 | 11.50 | 12.00 | 15.81 |
| September | 5.13 | 8.73 | 6.22 | 7.75 | 8.58 | 10.30 | 9.74 | 9.19 | 7.84 | 10.19 | 9.50 | 12.27 |
| October | 3.35 | 5.22 | 3.60 | 4.33 | 6.76 | 8.30 | 7.58 | 6.99 | 5.88 | 8.49 | 7.00 | 9.60 |
| November | 2.80 | 3.25 | 2.62 | 3.13 | 3.86 | 4.92 | 5.50 | 6.43 | 5.43 | 7.20 | 6.76 | 7.80 |
| December | 2.00 | 2.25 | 2.00 | 2.25 | 3.00 | 3.85 | 5.00 | 6.00 | 5.00 | 6.50 | 4.50 | 6.75 |
| Year | 53.65 | 81.56 | 42.21 | 47.37 | 86.95 | 105.33 | 107.25 | 114.99 | 94.35 | 126.53 | 94.51 | 137.76 |

HEATING PIPES EMBEDDED IN CONCRETE floors have been adopted in the plant of the Morse Chain Co. at Ithaca, N. Y. The pattern shop is heated by exhaust steam, the main machine shop by hot air and the blacksmith shop by flue gases. In each case the heating fluid is circulated through pipes or ducts embedded in the concrete floors.

The exhaust-steam system for heating the pattern shop is especially interesting. The building is 80 ft. long by 22 ft. 8 ins. wide, with a cubical contents of 32,250 cu. ft. The walls are monolithic concrete and the roof is plank with a covering of composition roofing material. The building is isolated except for a portion of the southern end. The steam pressure is 2 lbs. gage.

A 3-in. supply main and a 2-in. return main run along the western wall. The supply main is about 1 ft. above the floor level and is the only pipe in the system exposed so as to give any direct radiation. The return main is in a gutter with board covers along the wall below the supply main. From the supply main, 1-in. pipes extend across the building to the opposite wall, and loop back to the return main with a run of about 5 ft. parallel to the length of the building at the far end of the loop. In all there are nine such loops with a length of about 25 ft. and width of 5 ft. between legs of the loop.

Instead of being laid directly in the concrete, the 1-in. pipes are within 4-in. wrought-iron pipes buried in the floor with about ½-in. of wearing surface over their top sides. The total radiating surface is 310 sq. ft., of which only 80 sq. ft. (in the supply main) is directly exposed. Excellent results have been given by this system. Figures given for Jan. 4, 1910, when the outside temperature ranged from —5° to +11° F., show an inside temperature maintained at about 54° F. with variations of only about 1° at different heights between the roof and a point 1 in. above the floor.

The floor-heating system in all three variations of its application at the Morse plant is reported to have been especially successful in getting the heat down where it is needed, with results satisfactory to the comfort of the workmen. An illustrated description of the entire system was published in "Power and the Engineer," March 22, 1910.

# Under-Water Pile Saw with Guide Bracket for Cutting to Even Grade.*

By CLARENCE COLEMAN.†

The heads of the rubble mound breakwaters at Superior Entry, Wis., will consist of large timber cribs filled with stone ballast and seated on a foundation of piles cut off at an elevation of 2 ft. above the bottom of the lake and a maximum depth of 35 ft. below low-water datum. These piles are jetted in place with a water jet working under a pressure of 600 lbs. per sq. in., and then settled to their final bearing with a 3,500-lb. hammer. They are placed butt ends down and driven from 15 to 18 ft. in the sand. It is necessary that these piles should be cut off at an even grade for the reception of the cribs.

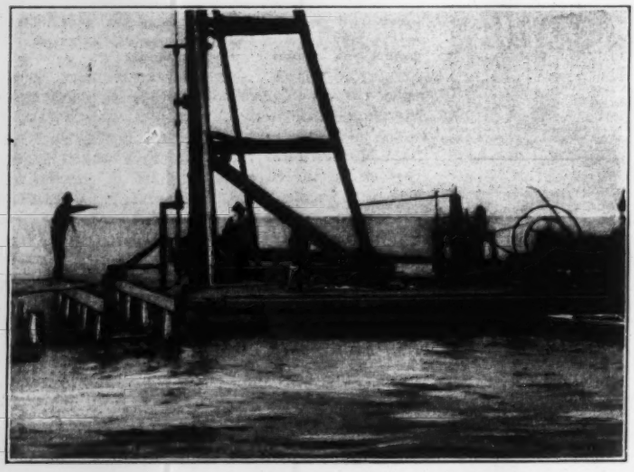


FIG. 1. PILE CUTTING MACHINE IN OPERATION AT SUPERIOR ENTRY, WIS.

Ordinarily the work of cutting off piles under water is performed by divers, by machines using either circular or straight cross-cut saws working from a trestle or by machines working from floating scows. In the case under consideration the conditions as to depth of water, risk from storms, and the interference with work on account of the existence of rapid currents, necessitated the design of an original machine for performing this work with accuracy and dispatch. With this in view a set of ordinary pile-driver leads was erected on a small scow, as shown on the accompanying drawing. A vertical beam 12 x 16 ins. x 56 ft. carries a steel shaft 3 7/16 ins. in diameter and 50 ft. long. This shaft is mounted on the beam with proper standards as shown, and the beam with the shaft is installed between the leads in such a manner as to travel vertically by means of a small hoisting engine on the scow to any desired elevation. A 48-in. circular cross-cut saw is attached to the lower end of the steel shaft, which is rotated by a belt connected with the driving engine on the scow. The steam is furnished by a 30-HP. horizontal boiler for the entire plant.

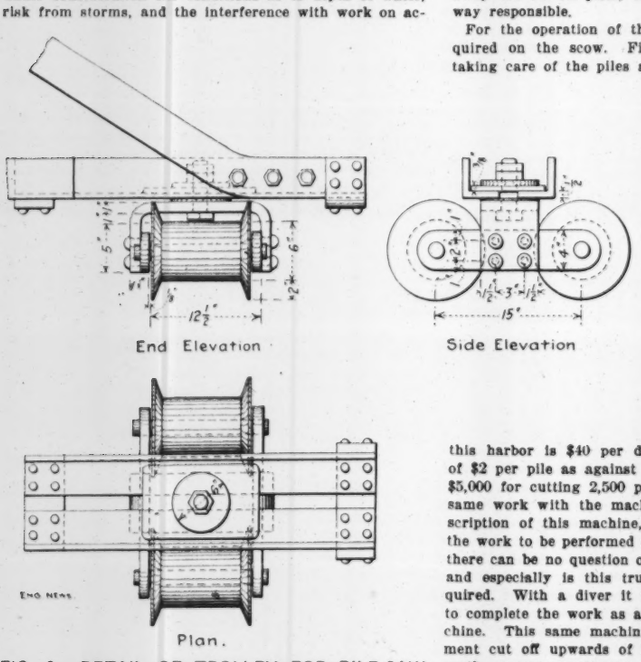



FIG. 3. DETAIL OF TROLLEY FOR PILE-SAW GUIDE BRACKET.

The special feature of this machine is the guide bracket constructed of steel and equipped with two double flanged trolley wheels designed to move on an 8 x 8-in timber cap which is placed on the row or bent of piles just forward of the row which is to be cut. These caps are moved ahead one row as often as the row immediately behind is cut and are lightly spiked in place until the next row has been cut, and so on until each row or bent has been cut. For cutting the last row, three special piles are driven for carrying the cap and afterwards removed. As stated, the guide bracket is the special feature, in that it insures cutting the piles to a perfectly even grade at the depth desired. It will be seen from the drawing that the bracket when its wheels rest on the cap fixes with great exactness the vertical distance between the top of cap and the saw, the elevation of the cap having been carefully determined by instrumentation from a U. S. B. M.

The shaft is rotated at a speed of 500 r. p. m., and the scow itself is controlled by proper lines operated from winch heads on the engine. The work is done very rapidly. With good weather and quiet water, the machine has frequently cut 45 piles per hour. The accuracy of the grade can be checked by measuring the cut-off piles and only errors of a few hundredths of a foot have been discovered. Delays occur through inability to clear away the cut-off piles, for which the machine is in no way responsible.

For the operation of this machine seven men are required on the scow. Five other men are engaged in taking care of the piles as they are cut off and cutting off piles above water and placing the caps for the guide bracket. The total cost per 8-hour day for crew, fuel and oil was $36.15. The results obtained may be tabulated as shown below.

On several occasions a bent containing 10 piles was cut off in 6 minutes. Diameter of piles at cut-off point was from 11 to 19 ins.

The work done by this machine could not be performed by a diver with such uniform accuracy. A day's work for a diver operating a hand saw rarely exceeds 20 piles. The average cost of a diver with his outfit in this harbor is $40 per day. This would mean a cost of $2 per pile as against 13.75 cts. for the machine, or $5,000 for cutting 2,500 piles as against $343.75 for the same work with the machine. From the foregoing description of this machine, it is easy to see that where the work to be performed is considerable, as in this case, there can be no question of the economy of the machine, and especially is this true when great dispatch is required. With a diver it would have required 125 days to complete the work as against nine days with the machine. This same machine without the bracket attachment cut off upwards of 2,000 piles for the north and south concrete revetment foundations at Superior Entry at a depth of 18 ft. below low-water datum and was then modified for the more accurate work on the cut foundations of the breakwater heads.

OPERATION DATA ON SAW.

| | |
|---|---|
| Time actually worked | 5 hrs. |
| Time worked, including transfer of machine and setting it in position | 7 hrs. |
| Number of piles cut off | 230 |
| Average time to cut off one pile, based on 5 hours' actual running | 1.3 mins. |
| Mean cost per pile at 230 piles in 7 hours | $0.1375 |
| Error of cut-off | ¼-in. and less |

The photograph (Fig. 1) shows the machine at work on the site of the breakwater head foundations. This photograph shows clearly the operation and use of the guide bracket. The machine was designed and built under the direction of Col. Graham D. Fitch, by the author and Mr. M. W. Lewis, U. S. Junior Engineer. With the exception of the vertical beam and shaft, with their accompanying devices, the machine is entirely made up of plant used for other purposes on the work; the boiler, engine, etc., being removed and used on other plant as soon as the purpose of cutting off piles has been accomplished.

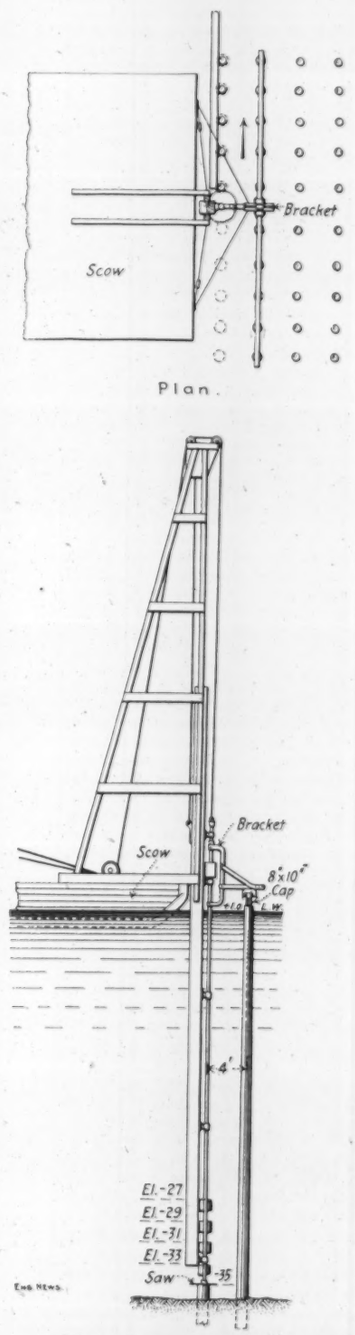



Fig. 2. Plan and Elevation of Pile Saw at Superior Entry, Wis., Showing Guide Bracket.

[A similar machine, but without a guide bracket, was described in Engineering News, Oct. 17, 1901, p. 282. The depth of cutting was adjusted in this machine by means of cross-lines painted on the vertical beam. The work was done for the piers of the bridge across the Charles River from Boston to Cambridge and piles were cut at the rate of 60 to 80 per hour—about twice as fast as at Superior Entry.—Ed.]

*Reprinted from an article in the quarterly publication of the U. S. Engineer School, Washington, D. C., "Professional Memoirs," Vol. II., No. 5, first quarter, 1910.

†U. S. Assistant Engineer.

## Decision of the Railroad Commission of Wisconsin in the Appleton Water-Works Case.

(Contributed.)

After several years of difficulties and litigation between the city of Appleton and the Appleton Water-Works Co., during which time the legislature of the state placed the regulation of Wisconsin public utilities in the hands of the Railroad Commission of Wisconsin, the city of Appleton appealed to and petitioned said commission for orders designed to give relief to the unsatisfactory situation. The petition set forth among other things that the quality of the water furnished by the company was wholly unfit for domestic and certain public uses, that the pressure maintained in the system was inadequate, especially for fire fighting, due to the fact that the pumping plant and water mains were greatly lacking in capacity to furnish adequate service, and that the company's rates were unreasonably high.

The company filed answer denying the allegations of the city and contending that its charges were unreasonably low and insufficient to enable the respondent to maintain its works, pay the running expenses thereof, provide for depreciation and renewals, and afford a reasonable return or interest on the fair value of its property.

The petitioner was represented by Greene, Fairchild, North & Parker (of Green Bay, Wisconsin), its attorneys, and the respondent by George Lines (of Milwaukee), its attorney.

The principal controversy between the parties to the case related to the value of the property upon which the respondent's returns from the operating revenues should be based. Much time and consideration were devoted by the able counsel representing the parties, respectively, to the fundamental principles involved in the valuation of public utilities for the purposes of this case. The commission states that the result of such labors was the illumination of many of the subjects arising in the course of the investigations.

The decision (which does not dispose of the question of rates, that being held in abeyance), presents a somewhat lengthy discussion of the subject of deriving fair valuations of such properties as that under consideration.

### Physical Valuation.

Four separate valuations of the plant under consideration were before the commission. Two were prepared on behalf of and presented by the city of Appleton. These were the work of Mr. Wm. H. Bryan, Consulting Engineer, St. Louis, Mo., and Mr. Geo. W. Sturtevant, of Chicago. The respondent company presented a valuation of its property prepared by Mr. Daniel W. Mead, Consulting Engineer, of Madison, assisted by Mr. C. V. Seastone. The fourth was made by the engineering staff of the commission, and has been referred to by the designation "commission valuation" for the sake of brevity. A very considerable part of the decision is devoted to a comparison of the four valuations and a discussion of the differences, not only in the grand totals but in the subdivision thereof. Several tables were prepared and presented in the decision by way of comparison of the various estimates. Tables I. and II. follow and show, respectively, the comparison of the valuations group by group and by totals.

A noteworthy point about the "commission valuation" (prepared by the commission's engineering staff), in connection with the fact that it falls so nearly midway between those of the city and company, is that this valuation was made in advance of the others.

The differences between the estimated costs of reproduction in the Bryan and Sturtevant valuations on the one hand and the commission valuation on the other were very closely accounted for by Mr. Bryan, who recasted the commission valuation, on the basis of prices used by him, as well as by Mr. Sturtevant, namely, prices prevailing at the date of the inventory, May 26, 1908. The commission and the Mead, or company, valuations were founded as nearly as practicable on the averages of prices during the five years ending with 1907.

The city offered in evidence the following statement by Mr. Bryan, prepared by him to show how much of the difference between his valuation and that of the commission's staff was due to difference in basis of prices:

| | Cost to reproduce. | Present value. |
|---|---|---|
| Commission (5-yr. average prices).... | $302,022 | $255,771 |
| Commission's valuation on May, 1908, prices ..... | 255,007 | 211,624 |
| Bryan valuation ..... | 256,577 | 187,215 |

The above figures tend to emphasize the importance of the question of basis of prices, but the subject is given further emphasis in the discussion of the same by both the commission and its engineers.

Concerning this the commission says in part:

> According to their (the city's engineers) testimony the price of cast-iron pipe on the date selected was $12 or $13 less than on the corresponding date in the previous year, and the price of labor was 10 to 20% lower. Due to the financial panic which began in the fall of 1907, the prices of material and labor were far below normal on the date selected. Obviously such prices do not afford an equitable or just basis for determining the fair present value of the property. The cost to reproduce at existing prices less depreciation seems to be regarded by the engineers of the city as the measure of the present fair value of the property, but we apprehend that any fair appraisement would have to rest upon a much broader basis in order to do justice to all parties concerned. If, perchance, the valuation should be made during a period of abnormally high prices, it is safe to say that those interested in keeping the valuation down would not contend that existing prices should control.

In this same connection the commission says further:

> Any measure of rates should be permanent for a reasonable length of time, otherwise it would be entirely impracticable. If the standard by which the reasonableness of charges is to be determined should fluctuate with the market prices of material, labor and land, no schedule of rates could be established for any length of time, for, under the circumstances, a rate that would be reasonable to-day might be very unreasonable to-morrow. The principles of the law applicable to the subject certainly involve no such absurd consequences.

The decision in this case contains the full text of a report submitted to the commission by its engineers, setting forth the views of the latter concerning the question of basis of prices. That report is here also presented in full.

### The Basis of Unit Prices Used by the Wisconsin Engineering Staff.

The basis of unit prices of physical property employed by the Commissions' engineering staff has from necessity been the subject of long and exhaustive investigation and study, due to the fact that for the most part the figures derived by this staff are submitted as information identically to two state commissions, dealing respectively with rate-making and taxation matters. Due to this situation, which is peculiar to the state of Wisconsin, the figures derived by the valuation staff are continually subjected to criticism and review from opposing view points; and this fact, it is found, tends strongly to eliminate any tendency towards bias on the part of the staff members in one or the other direction. Furthermore, a spirit of open-mindedness has been stimulated and enforced by the policy of the Railroad Commission in uniformly requiring its staff to critically review the informal or tentative physical valuation reports submitted as preliminary information, in the light of all available information before finally closing each case. Under this system there has been a maximum degree of freedom on the part of the staff in revising its procedure and in recasting its practice in such matters as the basis of unit prices.

HISTORICAL.—The general basis of unit prices employed by the Wisconsin valuation staff in valuing the physical properties of public utilities for the purposes of the Railroad Commission of Wisconsin is substantially the same as that adopted in 1903 for the valuation of the physical properties of the Wisconsin steam railroads under the direction of the State Board of Assessment. This and related matters were considered at a series of conferences held in 1903 at which the railroads were represented by their respective chief engineers and the Board by its engineer expert, Professor W. D. Taylor (now chief engineer of the Chicago & Alton Railroad and affiliated roads). As an initial step, the Board called in consultation Dean M. E. Cooley, of the University of Michigan, under whose direction there had then recently been completed an appraisal of the physical properties owned by Michigan public service corporations, including the entire railroad system (some 10,000 miles) and all telegraph, telephone, express company and related properties of that state. Two of the most important of the Wisconsin lines had taken a prominent part in the Michigan railroad appraisals, and this fact contributed much to the progress made by the Wisconsin conferences in formulating a basis of procedure, which followed closely the general lines of the Michigan practice. The essential features of the Michigan work, it should be stated, had been worked out by a special board of review composed of four prominent engineers, called together by the engineer in charge of those appraisals, and a similar function was performed in the 1903 Wisconsin valuations by the conference of chief engineers, representing upwards of 25,000 miles of railroad, acting under the guidance of the engineer expert of the Wisconsin Tax Commission.

In the Michigan practice, as formulated by the special board of experts and as worked out in detail by the valuation staff, the basis of unit prices varied somewhat according to circumstances. The underlying principle appears to have been to use the average prices for a term

TABLE II.—COMPARISONS OF TOTALS OF PHYSICAL VALUATIONS OF PROPERTY OF APPLETON WATER-WORKS CO.

| | | Cost to reproduce. | Present value. | Ratio present value to cost to reproduce. |
|---|---|---|---|---|
| 1. | City Valuations: | | | |
| 2. | By Mr. Bryan..... | $256,577 | $187,215 | 72.9% |
| 3. | By Mr. Sturtevant..... | 261,474 | 187,051 | 71.5% |
| 4. | Average city valuation. | 259,026 | 187,133 | 72.2% |
| 5. | Company valuation..... | 355,428 | 315,355 | 88.7% |
| 6. | Average of 4 and 5..... | 307,227 | 251,244 | 81.7% |
| 7. | "Commission valuation".. | 302,022 | 255,776 | 84.6% |
| 8. | Difference between 7 and 6. | 5,205 | 4,532 | 2.9% |

TABLE I.—COMPARISON OF SUMMARIES OF VALUATIONS OF PROPERTY OF APPLETON WATER-WORKS CO.

| Group. | Classification. | Cost to produce—City—Bryan. | Cost to produce—City—Sturtevant. | Cost to produce—Company. | Cost to produce—Staff of commission. | Present value—City—Bryan. | Present value—City—Sturtevant. | Present value—Company. | Present value—Staff of Commission. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Land | $5,150 | $5,000 | $10,810 | $5,150 | $5,150 | $5,000 | $10,810 | $5,150 |
| 2. | Wells, intakes and suctions | 11,224 | 12,307 | *19,246 | 14,936 | 7,143 | 7,351 | †17,620 | 11,412 |
| 3. | Reservoir | 10,637 | 12,135 | 15,648 | 12,521 | 9,041 | 11,226 | 15,345 | 12,271 |
| 4. | Distribution system | 134,532 | 139,601 | 175,290 | 162,400 | 114,397 | 110,453 | 165,230 | 148,216 |
| 5. | Power plant equipment | 30,236 | 28,708 | *27,451 | 30,407 | 11,533 | 9,960 | †15,901 | 15,006 |
| 6. | Buildings and miscellaneous structures | 27,607 | 26,633 | 39,739 | 28,045 | 11,330 | 14,905 | 29,333 | 20,649 |
| 7. | Office furniture and appliances | 125 | 125 | .... | 125 | 87 | 88 | ..... | 87 |
| 8. | Tools | 561 | 550 | 787 | 561 | 315 | 330 | 417 | 315 |
| 9. | Horses, wagons and miscellaneous | .... | .... | .... | .... | .... | .... | .... | .... |
| | Totals, Items 1-9 | $220,072 | $225,079 | $288,971 | $253,905 | $158,996 | $159,313 | $254,656 | $213,106 |
| 10. | Add for engineering and superintendence, interest, contingencies, etc | ‡26,408 | §28,135 | ‖46,122 | ‡30,469 | ‡19,078 | §19,914 | ‖40,919 | ‡25,573 |
| | Totals, Items 1-10 | $246,480 | $253,214 | $335,093 | $284,374 | $178,074 | $179,227 | $295,575 | $238,679 |
| 11. | Stores and supplies | 2,866 | 2,574 | 1,824 | 2,866 | 2,705 | 2,307 | 1,639 | 2,758 |
| | Totals, Items 1-11 | $249,346 | $255,788 | $336,917 | $287,240 | $180,779 | $181,534 | $297,214 | $241,437 |
| 12. | Paving | 7,231 | 5,686 | 18,511 | 14,782 | 6,436 | 5,517 | 18,141 | 14,339 |
| | Totals, Items 1-12 | $256,577 | $261,474 | $355,428 | $302,022 | $187,215 | $187,051 | $315,355 | $255,776 |

*$2,326 transposed from Company's Group 2 to Group 5.
†$2,120 transposed from Company's Group 2 to Group 5.
‡12% of totals of Items 1-9.
§12½% of totals of Items 1-9.
‖15% of totals of Items 1-9 and 12.
¶12% of totals of Items 1-9.

of years for such commodities and items of property as had been and would probably continue to be subject to large fluctuations in market prices; as, for example, the price of copper wire which was taken as an average of the market quotations for the preceding seven years, and the price of steel rails which was taken as an average of the prices for the preceding ten years. With respect to the steel rail prices, it should be explained that the conventional or fixed price due to trust control had been established but a short time before the Michigan appraisals were undertaken, the ten-year period assumed having seen violent fluctuations of the market quotations on rails. In the case of other items of property not subject to extreme fluctuations within brief periods of time, current prices were adopted in the Michigan work as being fairly representative of ordinary conditions in the reproduction of the physical properties then under investigation.

While the Michigan practice was adopted in most of its details, it was found expedient to modify some of the features of the work with a view to simplify and systematize the same as much as practicable. One of these modifications consisted in the adoption in the Wisconsin work of a five-year average basis for unit prices as far as consistent with circumstances, and this general basis has been adhered to as far as practicable throughout the several more or less distinct steps or stages which have marked the development of the work of the Wisconsin valuation staff. The more important of these steps, in the order of their occurrence, have been as follows:

(1) In 1903-4 the initial valuations of the physical property of the steam roads of the state for the information of the State Board of Assessment (Wisconsin Tax Commission) under the provisions of the 1903 ad valorem assessment law.

(2) In 1906-7, the use by the Railroad Commission, of valuation figures relating to the physical property of the steam railroads, in the passenger rate cases (A. E. Buell vs. C., M. & St. P. Ry. Co. and related cases involving the principal roads of the state), under the provisions of the 1905 railroad commission law.

(3) In 1907, the valuation of the physical property of the Milwaukee street railway company (city and interurban lines) for use by the Railroad Commission in the street car fare cases, and also under the 1905 street railway ad valorem assessment law for taxation purposes.

(4) In 1907, the initial valuations, also for the two commissions, of the physical property of the remaining street railway companies and the associated electric lighting and power plants of the state.

(5) In 1907-8, the initial valuation of the public utilities plants for rate making and accounting purposes by the Railroad Commission, under the requirements of the public utilities law.

These detailed valuations of physical properties aggregated some $206,000,000 in the initial year's valuation work (1903-1904), and the total for the year 1908-1909 was approximately $310,000,000, of which latter amount $303,000,000 covered the annual revaluations of steam and electric roads and the remaining $7,000,000 initial valuations of water, gas, electric and telephone properties.

With each succeeding step there has been a critical review of the basis and methods previously employed, both by the staff members and by the experts brought into the various causes which have occasioned the further valuation work. The initial steam-road physical valuations, for example, were made with such freedom from partisanship and in such spirit of co-operation between the state staff and the various railroad engineering departments that the results were accepted by the railroads when occasion later arose (1906) for the Railroad Commission to use the valuation figures in the passenger rate cases, mentioned in the second step of the above outline. Such early recognition of the underlying principle governing the work of the state staff engaged in the valuation of physical property (viz., that the results are derived quite irrespective of the purpose to which the figures are ultimately to be applied) led naturally to the action taken in connection with the valuation of the physical property of the Milwaukee electric railway system. These Milwaukee valuations included the entire city and interurban railway systems with the associated electrical properties involving physical properties to the amount of some $18,000,000. Being the first of this class of properties to be valued by the Wisconsin staff, the two commissions approved of the plan of calling in consultation Mr. B. J. Arnold, chairman of the appraisal board which had then recently completed the valuation of the Chicago traction properties (some $50,000,000). As a result of this contact with the Chicago situation, arrangements were made whereby there were temporarily transferred to the Wisconsin valuation staff Mr. George Weston, Mr. Arnold's chief of staff, and several of the departmental chiefs previously engaged in the Chicago traction appraisals. Conferences were held between members of the state staff and experts representing, respectively, the street railway company and the city of Milwaukee, at which the methods used by the staff were critically reviewed. The changes growing from these discussions were of an incidental character, the general basis remaining substantially as in the earlier appraisals.

After this review and the completion of the valuation of the Milwaukee properties the valuation of the physical properties of the remaining street railway companies of the state, including the electric lighting and power plants operated in association therewith, followed in natural order. In the course of these initial street railway valuations involving some 600 miles of road and 23 separate properties, about one-half of the lines being associated with lighting plants, numerous conferences were held for the purpose of explaining, on behalf of the two commissions, the basis and purposes of the valuation work and of seeking the criticisms and suggestions of experts with reference to the methods employed by the staff.

The most searching, and in certain respects perhaps also the most valuable, criticisms of the methods employed by the staff arose in connection with the first important valuations made under the public utilities law (in the Madison gas and electric rate case), this being the fifth and last stage enumerated above. Here for the first time in the history of the Wisconsin valuation work the results were to be used exclusively in connection with rate determinations. The able corps of specialists employed by the company, in collaboration with the commission's valuation staff, devoted several months to field examinations of the plant and to conferences with reference to the various phases of the valuation work. The question of the basis of unit prices to be adopted in valuations under the public utilities law was fully considered in all of its aspects, including the erratic condition of market prices during the progress of the field work in that particular case; the quotations on cast-iron pipe, for example, falling from the highest known maximum of $37 per ton in August, 1907, to $26 per ton in a period of nine months, following in parallel with other related commodities the general decline in pig iron prices.

BASIS OF UNIT PRICES.—Stated briefly it is the purpose of the Commissions' staff to derive figures which correctly and consistently represent the cost of reproducing the physical properties considered under ordinary or normal conditions; that is to say, figures which are not unduly influenced by the violent and erratic fluctuations of price recurring at varying intervals with certain important materials or items of property which in turn depend more or less directly upon the current price of base materials like pig iron or copper.

The fluctuations of price for a long term of years for one important item in the inventories of water and gas utilities properties, namely, cast-iron pipe, are illustrated in the accompanying diagram, which is typical of many similar statistical studies carried on by the Commissions' staff. The price of pig iron, which is omitted from the diagram, would be indicated by a wave line roughly parallel to the "monthly price" line and lying usually from $8 to $12 below it.

The initial point B on the "five-year average" line represents the value of the true average price of the preceding five years, which average is represented graphically by the heavy dotted horizontal line A-B. This line (A-B), it is seen, represents the average price of say $28.50 during a period in which the monthly price (the heavy wave line) fluctuated successively from $33 to $25 (from January, 1884, to January, 1886), thence up to $31.50 in the next year and a half, then down to a minimum of say $24.50 at the very end of the five-year period (December, 1888). In a similar way the fluctuations during the five-year period preceding May, 1908, (the approximate date of inventory in the Appleton water-works case) ranged from say $32 in the month of May of the year 1903 to less than $25 in 1904, thence up to the extreme maximum of $37 in 1907, and down to $26 at the close of the five-year period considered (May, 1908). Similar relationships are found to prevail in general throughout the 25-year period covered by the diagram and like observations may be made with respect to other materials which undergo erratic movements in their market prices.

The diagram of cast-iron pipe prices and the foregoing brief comments relating thereto are here introduced in a merely incidental way to illustrate something of the character of studies carried on extensively as a part of the work of the Commissions' staff. These studies are of course directed to local as well as general conditions affecting the work of the staff.

CONCLUSION.—In the light of extensive and critical studies covering the full range of physical properties involved in the work of the Commissions' valuation staff, supplemented by numerous conferences and discussions with experts, some interested, others entirely disinterested, the opinion is here recorded that the practice followed by the staff in fixing unit prices accomplishes the result demanded in this valuation work, namely, valuation figures which correctly and justly represent cost of reproduction new under what may be termed ordinary or normal conditions. The valuation figures derived by the staff are submitted as information to be considered by the Commission in connection with other similar figures which may be brought to their attention through other channels.

Respectfully submitted,

W. D. Pence, Engineer.

W. E. Miller, Assistant Engineer.

A part of the differences between the cost to reproduce as estimated by the city's and the commission's engineers on one hand and the company's engineer of the other is regarded as due to the difference in the assumed manner of constructing the duplicate plant. The valuation by Mr. Mead was based on a comparatively small starting plant, or system, and adding to that by piecemeal construction, in accordance with the history of the actual plant. The other valuations were made largely on the idea of continuous construction of the plant as it exists, although the engineer of the commission testified that the fact that a part of the property was the result of piecemeal construction was constantly kept in mind during the preparation of his valuation, and that whatever difference exists between costs under continuous construction and piecemeal construction properly supervised and prosecuted had been allowed for. Mr. Benzette Williams, Consulting Engineer, Chicago, who appeared in behalf of the company, testified that he could not tell whether the actual difference between piecemeal and continuous construction costs would be large or small, as the amount depended upon the facilities which the company had for making its extensions from time to time

### Depreciation.

The present or existing values of the property derived by the several engineers were, of course, the differences between their respective estimates of the cost of reproduction and the depreciation. In computing depreciation which had occurred the appraisers were influenced by fundamentally different considerations. The amounts of depreciation charged by the several engineers to a given item or unit were discussed by the commission in its detailed analysis of the evidence presented.

After careful consideration of the several valuations, part by part, the testimony taken in the hearings, and revised figures submitted by its engineering staff, the commission concluded

that the fair reproductive value and present value of the physical property, constituting the respondent's water-works at Appleton, is shown by the following summary of groups into which the property has been classified by the engineers for the purpose of appraisement [Table III.]:

### Intangible Elements of Value.

In considering the subject of "going value" the commission refers to its decision in four previous utility cases wherein the principles announced were exhaustively considered. Repetition of those discussions were regarded as quite unnecessary in this case, yet one phase of the subject presented in the cases cited has been amplified here because of its bearing on the case in hand.

This has to do with the exceptional circumstances under which the entire excess of cost over operating revenues incurred in developing the business and establishing the same upon a self-sustaining basis is not the inflexible criterion by which the element of going value is measured.

In concluding for the present the treatment of the above subject, the commission says:

The plant, as it stands to-day, is incapable of earning upon the present value of the physical structure what under ordinary circumstances would be regarded as a reasonable return upon the investment. It is now being operated by a receiver appointed by the Federal Court in an action brought to foreclose the mortgage or deed

TABLE III.—FINAL VALUATION OF THE PROPERTY OF THE APPLETON WATER-WORKS CO., AS FIXED BY THE WISCONSIN RAILROAD COMMISSION.

| Group. | | Cost of reproduction. | Present value. |
|---|---|---|---|
| 1. | Land | $5,150 | $5,150 |
| 2. | Wells, intakes and suctions | 14,560 | 14,251 |
| 3. | Reservoir | 12,521 | 12,271 |
| 4. | Distribution system | 155,954 | 150,221 |
| 5. | Power plant equipment | 25,571 | 10,588 |
| 6. | Buildings & miscel. structures. | 28,045 | 20,649 |
| 7. | Office furniture and appliances | 125 | 87 |
| 8. | Tools | 561 | 315 |
| 9. | Horses, wagons & miscel. | .... | .... |
| | Total Items 1—9 | $242,487 | $213,532 |
| 10. | Add 12% (See note below) | 29,098 | 25,624 |
| | Total Items 1—10 | $271,585 | $239,156 |
| 11. | Stores and supplies | 2,659 | 2,659 |
| | Total Items 1—11 | $274,244 | $241,815 |
| 12. | Paving | 617 | 587 |
| | Total Items 1—12 | $274,861 | $242,402 |
| 13. | Non-operating property | 4,133 | 211 |
| | Total Items 1—13 | $278,994 | $242,613 |

Note: Addition of 12% to cover engineering, supervision, interest during construction, contingencies, etc.

of trust given to secure the bonds of the company. If a sale were contemplated to satisfy a judgment in such action, any purchaser other than the bondholders or possibly the City of Appleton would probably not bid much in excess of the present value of the physical property. Under the circumstances, the going value of such a plant as an independent factor in the appraisal would be but nominal. When the plant is reconstructed and placed in such a condition that it will be able to furnish water at all times suitable for domestic consumption, and also adequate fire pressure, further consideration will be given to this branch of the case.

### Franchise Value.

A discussion of franchise value as an element to be included in a valuation for rate-making covers more than five typewritten pages of legal size. In this it is conclusively shown that no such element can be allowed in the present case. In fact, the Wisconsin statute now expressly prohibits the capitalization of any special franchise granted by a municipality at a greater sum than the sum paid therefor into the public treasury (Sec. 1753-9). No claim of value for this element, however, was made by respondent in this case.

The commission temporarily disposes of the case with the following:

In view of the fact that the respondent's plant is not in condition to render reasonably adequate service and that large expenditures will be required to put the same into efficient operating condition, investigation into the financial history of the company will not be prosecuted until the company has completed the work herein ordered to be done. When the plant is in position to perform its public function according to the measure of duty devolving upon the company, we shall establish a schedule of rates for public and private consumption which will be adequate to meet the conditions as they then exist and which will be just to the investors and fair to all parties concerned. The situation will again be reviewed and the value of the investment determined in the light of all the facts involved in the inquiry at such time. The matter of rates will be permitted to remain in *statu quo* pending the reconstruction of the plant, as no rational adjustment can be made under existing circumstances.

The various engineers, who testified upon the hearing, suggested different plans for the reconstruction of the plant, but the plan that shall be adopted is a matter primarily for the respondent to determine. The public is only interested in the result. For the protection of property against loss by fire it is imperative that the plant be able to furnish adequate fire pressure at the earliest possible moment. The city is at present without adequate fire protection.

NOW THEREFORE, IT IS ORDERED, (1) That the respondent shall take whatever steps may be necessary for securing and maintaining permanently a reasonably adequate supply of pure and wholesome water; (2) that the respondent make such additions, alterations and repairs as will render its water-works adequate and efficient for the purpose of supplying the municipality of Appleton and its inhabitants with reasonably adequate service; and (3) that the respondent hold itself in readiness at all times to comply with the provisions of the franchise granted to it by the city of Appleton respecting fire streams and fire service. Three months is deemed a reasonable time within which to comply with this order.

The above order of the commission was signed and issued May 14, 1910.

## Reports on the Disposal of the Sewage of the Calumet District of Chicago and Its Relation to the Chicago Drainage Canal.

What to do with the sewage of the Calumet River section of the Sanitary District of Chicago has been a troublesome question ever since the boundaries of the District were extended in 1903 to embrace that section. A report reviewing the subject and recommending a line of action was submitted to the Board of Trustees of the Sanitary District of Chicago on May 11, 1910, by the Board's Committee on Engineering. The report was supplemented by letters from a number of engineers and sanitarians, most of whom are connected with the Board. We abstract the report and the various letters as follows, treating some of them briefly because their substance is given in some of the other documents:

### Report of Committee on Engineering.

Your Committee on Engineering is of the opinion, that it is advisable at this time to state its position to the Board of Trustees of the District with reference to the question of affording relief to the Calumet District from the contamination of its water-supply by the sewage which flows into Lake Michigan through the Calumet River.

As early as 1904 the Board of Trustees passed ordinances establishing a route for a channel extending from its main drainage channel near the Sag, to connect with the Calumet River at a point east of Blue Island. In 1905 it was found that the channel as planned could not be sufficiently supplied with water unless it was extended to the improved portion of the Calumet River and your committee at once formulated a plan for its extension. But at the same time there arose vexatious engineering and legal problems, which have continued to the present time.

The most serious of these were (1) the recommendation of the International Waterways Commission (appointed to draft a treaty between the United States and Great Britain) to limit, forever, the amount of water which could be drawn from the southern end of Lake Michigan to 10,000 cu. ft. per sec; (2) the reports of experts submitted by that commission that the sewage of the Calumet District could be disposed of in other ways than by water dilution, and (3) the refusal of the Secretary of War to permit the District to withdraw from Lake Michigan an additional 4,000 cu. ft. per sec. through the proposed Calumet-Sag Channel.

Then came the filing of a bill of complaint by the United States to enforce the decision of the Secretary of War by a perpetual injunction, which suit is a battle of hydrographic experts and is still waging in the Circuit Court of the United States for the Northern District of Illinois. Also an unsuccessful suit in the Supreme Court of the State of Illinois to declare the Sanitary District Act of 1903, extending the boundaries of the District, to be unconstitutional. And last, but not least, the recent refusal of the Secretary of War to permit any water to be withdrawn from Lake Michigan by way of the Calumet River, or in any manner to reverse its flow.

Your committee has not waited upon the determination of the suits referred to by the courts, but has steadily sought to find an efficient substitute for the method imposed on the District by law to dispose of the sewage of the entire district by water dilution, so that, if in the end the refusal of the Secretary of War to permit the flow of the Calumet River to be reversed was sustained by the courts, relief could be obtained in some other way.

The Board of Trustees has considered every phase of sewage disposal which has been brought to its attention. It has especially considered the broad questions of the advisability of constructing a sewage disposal plant, the effluent of which could be discharged into the lake or into the proposed channel, and of constructing a system of intercepting sewers and controlling works.

The Trustees had published in pamphlet form the exhaustive report of Messrs. Hering & Fuller to the International Waterways Commission on "The Disposal of Sewage of Chicago in the Calumet Region," dated Dec. 18, 1906; and procured and published a comprehensive report by Mr. Rudolph Hering to the President of the District on the "Sewage Disposal of the Calumet Region," dated Oct. 15, 1907; and a report by the Chief Engineer, Mr. George M. Wisner, dated June 9, 1909.*

In addition to obtaining the reports of eminent experts on sanitation and hygiene, early in 1909 your Board authorized the construction of an experimental station at the 39th St. pumping works where the operation of the more rapid forms of sewage treatment by the use of settling tanks and sprinkling filters could be studied, under the conditions obtaining in Chicago. This plant was placed in charge of Assistant Engineer Langdon Pearse, with Dr. Arthur Lederer as Chemist and Bacteriologist. For more than a year there has been conducted a series of chemical and bacteriological analyses of sewage, and experiments to determine the safest way to dispose of the effluent from the settling tanks and the filter beds.

A full description of the experimental plant appears in an illustrated article in Engineering News of March 31, 1910, and was reprinted in pamphlet form by the District.

As time has passed, the population of the Calumet River District has largely increased, and there has been a corresponding increase in the contamination of its water-supply, not only from the growth in population, but also by reason of the location in that district and in northern Indiana of many large manufacturing plants, which discharge into the Calumet River industrial waste, some of which is highly favorable to the growth of bacteria.

Your committee further reports that by reason of the refusal of the Secretary of War to grant a permit to take through the Sag Channel 2,000 of the 10,000 cu. ft. already permitted to be withdrawn from Lake Michigan, it has during the past few weeks again reviewed the entire subject of the contamination of the water-supply of the Calumet District, and presents herewith reports and communications relating thereto from its Consulting Engineer, Mr. Isham Randolph; its Chief Engineer, Mr. George M. Wisner; its Assistant Engineer, Mr. Langdon Pearse; its Chemist and Bacteriologist, Dr. Arthur Lederer; from Dr. William A. Evans, Health Commissioner of the City of Chicago, and from Mr. C. D. Hill, Engineer of the Board of Local Improvements of the City of Chicago, all of whom are experts of high standing in matters of sanitation, hygiene and the public health.

From the reports and communications mentioned, it is apparent that the present condition of the Calumet River and the extreme south end of Lake Michigan is simply intolerable and, unless rectified, will result very speedily in a serious epidemic of typhoid and other diarrheal diseases among the 500,000 people using water from the 68th St. intake. And, as the water mains of the entire city are inter-connected, occasions may arise when the water from that pumping station may flow beyond its normal territory and extend an epidemic.

The vital statistics of the industrial towns in Indiana at the foot of Lake Michigan, when compared with the vital statistics of the population in Chicago living under practically the same conditions as to food, climate and shelter, also demonstrate that the death rate from typhoid fever and other diarrheal diseases is practically 25 times as great as prevails in the city of Chicago. This abnormal condition can only be attributed to the fact that their water-supply is grossly contaminated by pathogenic germs, introduced by sewage.

It further appears from the report of your Chief Engineer that at the present time there are sewering into the Calumet River from the territory of the Sanitary District nearly 130,000 people and probably as many more living in the State of Indiana, and it is not only to remedy the condition which now exists in that part of the Sanitary District which lies within the Calumet District, but to place the Sanitary District in a position where it can vigorously protest against the contamination of a common water-supply by the people of an adjoining state, that it is now necessary for the Board of Trustees to afford the people of that district such relief as it is able to do, in the face of the engineering and legal problems which have so long confronted and still do confront the Board.

Your committee is, however, of the opinion that the officials of the State of Indiana and its municipalities which border on Lake Michigan will at once cooperate with this District to prevent further contamination of the common water-supply if they are convinced that the Sanitary District is taking actual steps to abolish unsanitary conditions within its own boundaries.

Your committee, before coming to any conclusion, again considered the advisability of constructing a system of intercepting sewers and of the building of a filtration plant for the purification of the sewage of the Calumet District, but, as is well stated by Dr. W. A. Evans, in his letter of April 28, 1910, to the Chief Engineer of the District:

The state of the art of sewage purification by mechanical separation, bacterial action, oxidation and filtration probably has not advanced to the point where it would be safe to place the effluent in a quiet body of water so close to intakes used for drinking-water supplies.

In addition to this objection, the cost of adequate sewage purification on a large scale, as shown by the estimates of our engineers, is almost prohibitive.

There appears to be but one remedy available. The sewage of the District, whether subjected to purification processes or not, must be kept out of the Calumet River and Lake Michigan, and an outlet provided for its diversion.

Your committee is of the opinion that it is the duty of the Board of Trustees of this District to furnish such an outlet for the sewage of the Calumet District at once by acquiring the necessary right of way and proceeding to construct a channel to connect the Main Drainage Channel, at the Sag, with the Little Calumet River at a point just east of Blue Island; and that, until the question of the right of the District to take additional water from Lake Michigan through the proposed channel is fully determined, it will dilute the sewage which will necessarily flow into the channel by taking the normal flow of the Little Calumet River, amounting to about 720 cu. ft. per sec., and storm water drainage, which will result in preventing the scouring of the channel of the Calumet River lying in South Chicago into the lake for most of the time during the year.

Respectfully submitted,
Wallace G. Clark, Chairman.
Edward I. Williams,
Committee on Engineering.

*See Eng. News, Jan. 31, 1907; Nov. 7, 1907, and Nov. 18, 1909.—Ed.

The following are the letters [condensed] submitted with the report of the committee:

### Letter from Mr. Isham Randolph.*

The Calumet River is the natural channel of relief for large drainage areas in Illinois, and for still larger areas in Indiana; and these areas are well adapted to the needs of industrial communities and so manifest is this adaption that manufacturing plants are taking up the lands and thousands of operatives are making their permanent homes. Every such settler is a contributor to stream pollution.

The flow of the Calumet River must be diverted from Lake Michigan and a new outlet must be found for it. As in the case of the Chicago River, Nature had outlined an obvious route for a westward-flowing channel, so in the case of the Calumet, Nature has provided the Sag Valley through which—at moderate expense compared with the results to be accomplished—a channel can be

*Consulting Engineer, Sanitary District of Chicago.

cut that will carry the flow of the Calumet River away from the lake and discharge it into the Main Channel of the Sanitary District where the Sag Valley merges into the Des Plaines Valley.

Every argument against the construction of this channel is commercial and grows out of the fear that the taking of water from Lake Michigan to safeguard life and health will slightly curtail the earnings of the lake fleet or by a small percentage diminish the volume of water which may be abstracted from the Niagara River for water-power development.

Water from Lake Michigan has been flowing westward through the Sanitary Canal for ten years and four months and navigation interests have not suffered an atom's loss in carrying capacity. The lake stages as observed and recorded by the Engineers of the U. S. Army afford the only authentic source of knowledge bearing upon that feature of the controversy between the Sanitary District of Chicago and the Government of the United States. The published hydrographs which set forth the facts show that between December, 1894, and January, 1900, the level of Lake Michigan reached 581 once only. In August, 1899—the highest stage—the elevation was 581.05, whereas in 1901, it reached an elevation of 581.10; in 1904, 581.45; 1905, 581.65; 1906, 581.45; 1907, 581.55; and in 1908, 581.85; and in all the years since 1899, the low water has never been so low as it averaged in the nine years previous to 1900, and the difference in favor of the later period is not accounted for by excess of rainfall in the years since 1900, as disclosed by the records published by the government.

The theories advanced by the Government Engineers have not been sustained by the facts, which they record faithfully and present fearlessly.

The International Waterways Commission has said in its 1905 report:

> It is the opinion of the Board that the sanitary reasons for the abstraction of water so far exceed and overshadow the commercial reasons that the amount should be strictly limited by the sanitary necessities of the case.

That is a broad humanitarian principle, well expressed, but the application of the principle to the necessities of Chicago's sanitation is denied by the very men who gave it utterance. Chicago needs 14,000 ft. per sec. for the proper dilution of its sewage; or, more properly speaking, it will need that volume before the channels to accommodate the flow can be provided. Of this needed volume, 10,000 should flow through the Chicago River and the 39th St. conduit, and 4,000 cu. ft. should flow through the Calumet-Sag Channel.

The construction of the Calumet-Sag Channel is essential to the protection of Chicago's water-supply. No alternative now known can be as effective and no substitute for it can be provided as economically or as quickly. In my judgment the construction of this canal should not be further delayed.

### Letter from Mr. G. M. Wisner.*

In a former report I recommended that a 2,000 cu. ft. per sec. canal be built, giving reasons and an estimate of the cost. I recommended this as the most feasible and economical method. It now develops, however, that if the District is not to be allowed to take water from the lake for diluting purposes it would not be good practice to convey the sewage in an open channel without any dilution. But I am firmly convinced that public sentiment is such that it will not be stopped from taking part of the 10,000 cu. ft. per sec. through the channel by way of the Calumet River, and even if it were, there would be no opposition to taking the normal flow of the Calumet River through a channel to the Drainage Channel, thus preventing the scouring out of the filth of the Calumet River lying in South Chicago into the lake. This normal flow is about 700 cu. ft.—the sewage flow is about 525 cu. ft., making in all about an average of 1,200 cu. ft. per sec. In case no dilution can be obtained it will be necessary, as I see it now, to build a sewer from Blue Island to the Sag.

So only one of three schemes can be carried out: First, build a sewer of 525 cu. ft. capacity; second, build a 1,000 cu. ft. canal; and third, build a 2,000 cu. ft. canal. The estimated cost of these three projects, figured on a comparative basis (without any money being spent on the canals for navigation features) are: First, for the sewer, $4,240,000; second, for the 1,000 cu. ft. canal, $4,300,000; and third, for the 2,000 cu. ft. canal, $5,640,000.

It would seem to me from these figures and from public sentiment that the Sanitary District would be justified at this time in starting the work of securing the right of way and the construction work for building a 2,000 cu. ft. canal.

### Letter from Mr. Langdon Pearse.†

Of all the methods proposed for the disposing of the sewage of the Calumet region, the construction of a canal is the best. The reasons for this are clearly defined in my mind. The cost is low. The maintenance and annual cost is light. But aside from cost, the sanitary reasons are of weight. Our experiments at 39th St. would indicate (even though as yet incomplete) that sprinkling filters alone do not produce an effluent of sufficient purity to be discharged into Lake Michigan in the volume to be expected in the Calumet region. The bacteriological purification is uneven and fluctuates. Some further treatment would have to be used, either sterilization or filtration. In the present state of the art of sewage disposal, it will be a bold precedent to discharge even such a purified effluent into the lake, under the conditions we are discussing. Most sanitarians are agreed that all sewage, even purified, should be kept out of water-supplies as far as possible. No sewage purification plant is fool-proof, nor as capable of exact handling as a water purification plant. Hence I think the human element in the control is a factor well worth considering in such a case as this.

The Calumet watershed is interstate, lying partly in Indiana and partly in Illinois. Undoubtedly the Indiana towns may sincerely attempt to purify their sewage before discharging it into the river and lake. But what quick, certain relief would we have if their plants did not work? A canal, on the other hand, would act as a safety valve, and sweep all such occasional pollution away from the lake.

There is a deal of shipping now entering the Calumet and the number of vessels is bound to increase. This means that more or less fecal waste will enter the river, which a purification plant cannot reach. Unless a canal be built, all such pollution, as well as surface wash, will be carried into the lake.

The storm-water problem, too, is favored by the canal. To treat it adequately will require a large area of filters. If the interceptors be built as planned, to discharge at times of storm into the river direct, only a canal can then save the lake from pollution. For even dilute storm sewage from combined sewers carries with it the elements of pollution.

### Letter from Dr. Arthur Lederer.*

Since the opening of the Drainage Canal, no more serious problem has come before the Sanitary District than the problem of the Calumet District. Three factors have brought the gravity of the situation to light, namely: The continuous abnormally high death rate of the Indiana towns bordering on the lake, the work of the Lake Michigan Water Commission, and the scientific investigations of Mr. H. E. Barnard, Chief Chemist of the State Board of Health of Indiana. A chemical and bacteriological survey of the southern portion of Lake Michigan, adjoining Lake County, shows the water to be grossly polluted and unfit for drinking purposes. This is due to the great volume of sewage and manufacturing wastes discharged into it by the Calumet River, by the glucose sewer, and by the sanitary sewers of Gary, Indiana Harbor, East Chicago, Whiting, and that portion of Hammond known as Robertsdale, as well as the sewage from that portion of Chicago south of 89th St. A further source of pollution is the dumping of material dredged from the Calumet River. At times of flood the current will run out of the Calumet River at a rate of 5 or 6 miles an hour for days at a time, contaminating the water-supply of Indiana Harbor, East Chicago, Whiting, and Hammond. Even the water-supply of the southern portion of Chicago is affected, for when off-shore winds prevail, streams of muddy water can be seen in the lake for several miles out, reaching to the west as far as the Hyde Park crib of the Chicago water-works.

At this writing, we can pride ourselves, in Chicago proper, on having one of the lowest typhoid fever death rates in the United States. This is undoubtedly due to the removal of sewage from the lake into the Main Channel. To the sanitarian who is familiar with the conditions of the southern end of Lake Michigan, however, this is a distinct surprise and can only be explained by the great purifying power of the Lake Michigan water and the present dilution. Having been fortunate enough to escape serious consequences so far we should heed the warnings coming at this time. There is no one who is in any way familiar with the problem who does not consider a diversion of the sewage poured into the lake directly, as well as through the Calumet, an imperative necessity and vital to the welfare of Chicago. It is indeed a calamity that the Sanitary District at present is not proceeding at once with the building of the Calumet-Sag canal, for it is the logical solution, from a sanitary standpoint.

While the work at the experimental sewage disposal plant is far from being completed, I think it has proved that it is not safe to discharge sprinkling-filter effluents without further purification into a body of water which is used as a water-supply. The bacterial purification is subject to large fluctuations, even with close control. Such an effluent should be first subjected to disinfection, which is a comparatively simple and cheap procedure, or sand filtration. In any case, the human element is in control, with an apparatus which cannot be made fool-proof.

### Letter of Dr. W. A. Evans.*

For two years some part of my time has been devoted to a study of water-borne diseases and water pollution at the south end of Lake Michigan. The importance of this first came to my attention as Health Commissioner of Chicago. I was then made a member of the Lake Michigan Water Commission and my field of observation was widened. I know the following to be facts:

(1) The water from the 68th St. intake is frequently polluted.

(2) 500,000 people use water from that intake.

(3) The district supplied by this intake is developing population faster than any other part of the city.

(4) The distance from the mouth of the Calumet River to the 68th St. intake is too short for the purification of any considerable volume of sewage flowing out of the mouth of the river and towards the intake—regardless of even the lowest wind velocity.

(5) The direction of surface sewage flow is with the direction of the wind.

(6) The direction of deep sewage flow is usually in the opposite direction to the wind.

(7) The typhoid rate of the part of Chicago south of 45th St. (supplied by the 68th St. crib) is increased by water pollution.

(8) The towns in northwestern Indiana have water intakes within five miles of the mouth of the Calumet River.

(9) The distance from the mouth of the Calumet River to any one of these water intakes is not sufficiently great to purify a considerable volume of sewage when the direction of the sewage stream is from the mouth of the river to the water intake.

(10) South of an east and west line drawn through 81st St. and across the lake—the water of the lake is so polluted that some time will be required for it to "clear," even after all sewage and dumping is kept out of it.

(11) These towns are now well populated and growing rapidly.

(12) Their typhoid rate has ranged from 200 to 1,400 per 100,000 living, as compared with Chicago's 12 per 100,000 living.

(13) Of the several sources of lake pollution in this district the Calumet River is much the most important, since it receives many times as much sewage and manufacturing waste as any of the others.

(14) The present prosperity of these towns is being imperiled and their future is being blighted by their high sickness rate, due to bad water.

(15) This sewage must be kept out of the drinking water-supplies drawn from Lake Michigan by Chicago and the other towns at the foot of the lake.

(16) No other water-supply for them is available.

(17) The best way to dispose of sewage in and around Chicago has been to divert it into streams which are not used for drinking purposes, where there is length of flow and dilution sufficient to purify it.

(18) The state of the art of sewage purification by mechanical separation, bacterial action, oxidation and filtration probably has not advanced to the point where it would be safe to place the effluent in a quiet body of water too close to intakes used for drinking water supplies.

### Letter from Mr. C. D. Hill.†

The sewage problem of the Calumet District must necessarily be solved in one of three ways, first by dilution, which involves the construction of the Sag Canal, secondly by filtration, thirdly by the combination of the two methods. As I have stated in public, I believe that ultimately the third method will be used, but that will be after many years when the population of Chicago is too great for the dilution method. As a practical proposition, it is necessary to decide at this time upon which of the other two methods is to be used first.

To my mind, one of the strongest arguments in favor of building a canal instead of erecting filtration works is that under the law, as I understand it, the Sanitary District can proceed at once to do this work and in a comparatively short time the desired result can be accomplished. If you were to build filtration works, you would have to get new authority from the State; you would have to decide on the exact method; it would take considerable time to locate proper sites for the works; it would be necessary to build a complete system of intercepting sewers leading to the proposed works; and the construction of the works would occupy nearly or quite as much time as it would to excavate the canal.

It is reported that the Trustees have instructed their engineer and attorney to prepare the ordinance necessary to initiate the work recommended by the engineering committee.

*Chief Engineer, Sanitary District of Chicago.
†Assistant Engineer, Sanitary District of Chicago.

*Chemist and Bacteriologist, Sanitary District of Chicago.

*Health Commissioner of Chicago.
†Engineer, Chicago Board of Local Improvements.

## A Steamship with Horizontal Corrugations Along the Hull: Results of Tests.

The screw steamer "Monitoria," recently built in England, is a cargo vessel of about 4,500 tons displacement. Her hull differs from the ordinary form in having two large horizontal corrugations running along each side from stem to stern. The upper corrugation is just below the load water line. Tests of this vessel, in which it was compared with sister ships exactly similar except for the corrugations, showed a distinct advantage in favor of the new type of hull in horse-power required with a given load at a given speed.

The results of the tests are described in a paper read before the Feb. 18, 1910, meeting of the North East Coast Institution of Engineers and Shipbuilders (England) by Mr. A. H. Haver. Extracts from this paper are given below. The "Monitoria" was built by Osbourne, Graham & Co., of Sunderland, England, and is owned by the Ericsson Shipping Co., Limited, of Newcastle, England.

The lines of the vessel, the engines, boilers and propeller, also the general arrangement and coefficients are the same as several other vessels built by the same builders. The only difference between them and the "Monitoria" is in respect to two horizontal projections running along between the load line and the bilge on each side of the hull. These projections are formed in the shell plating by curving it out 11 ins. beyond the side framing. In section these are shown in the illustration to be rather flat arcs gradually curved into the normal flat side of the ship above, below and between these corrugations. They are tapered away gradually at the ends as far as the round of the bows and quarters until they merge into the normal form of the ship's ends. These corrugations have been found to be of great advantage to the ship in respect to her seakindliness, speed and carrying capacity.

Comparing the highest speed and horse-power with the sister ships show that, whereas the corrugated ship is carrying 411 tons at 10 knots with an expenditure of 100 I.HP., the plain ship No. 1 carries only 359 tons and No. 2 ship 350 tons at the same speed and horse-power, showing the corrugated ship to be 14.5% and 17.4% respectively a better carrier than the plain ships. The indicated horse-power for the "Monitoria" as shown in the accompanying table, was 986 with 65.8 r. p. m.

The ship with plain hull at the same speed and displacement showed 1,116 I.HP. and 70.14 r. p. m. This appears to show that the wake eddy and wave resistence must be less in the corrugated ship.

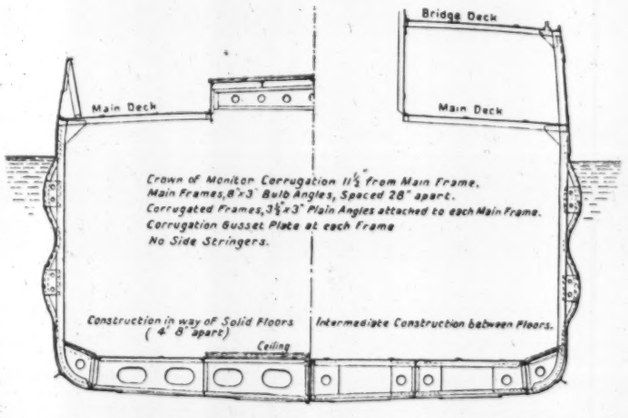
The idea started with was a groove in the side within the body of the ship. Encouraging results were attained with this, but the extra construction work on the inside, if vertical frames were adopted, and the loss of displacement made it advisable to adopt corrugations projecting outward from the frames.

When the writer was invited to join the Monitor Shipping Corporation to develop this invention, he at first gave a decided adverse opinion regarding its worth. He believed in common with what he understool to be the prevailing accepted opinion that as this involved an increase of wetted area it meant, without doubt, an increase in horse-power.

Numerous experiments with varying measures of success appeared to prove that the generally accepted law did not meet the case, and he was obliged to admit that the experiments although made under a strong prejudice disclosed an improvement which proved the soundness of the idea, and, with further trials and experiments, might prove a valuable and far-reaching improvement in the propulsive efficiency of all classes of vessels. The preliminary experiments were made in the experimental tank invented by the late Mr. Frank Caws, Sunderland. This is equipped with a ship resistance meter whose motive force is gravity transmitted through a pendulum. Mr. Caws explained his principle to this institution in 1893. To those who are not acquainted with the principle, I may briefly say that the pendulum bob is raised to a certain initial angle and in its fall by gravity through the versine of the angle carries the ship along with it. The ship, of course, is floating freely on the surface of the water.

As the force is exhibited by the sine and the energy by the versine, so the time and speed of pendulum are shown by the arc of amplitude, the horse-power expended being the difference between the initial and final versine. Whatever difference of opinion there may exist regarding the trustworthiness of this system of testing ship's resistance, there can be no doubt whatever that in testing a vessel with Monitor corrugations by this method a final angle greater than that resulting from a similar trial of a plain ship would prove that the resistance is less for the Monitor vessel. A trial of a model plain and then with corrugations under identically similar conditions ought to be a fair test.

In the case of the vessel already built, the experimental results have been found to be fully realized. In the absence of an actual progressive speed curve for the plain ships Nos. 1 and 2, the actual result has been adopted for the plain ship at the 9.78-knot spot compared with the actual horse-power attained at the same speed by the corrugated ship on her trial trip under three conditions: First, compared with the corrugated ship at the same speed but 125 tons more displacement, viz, 4,575 tons; second, at the same horse-power and 125 tons more displacement, viz., 4,575 tons; third, at the reduced displacement of 4,450 tons the same as the plain ship and at the same speed. These results are shown in the table.


Bridge Deck
Main Deck
Main Deck
Crown of Monitor Corrugation 11½" from Main Frame.
Main Frames, 8"x3" Bulb Angles, Spaced 28" apart.
Corrugated Frames, 3½"x3" Plain Angles attached to each Main Frame.
Corrugation Gusset Plate at each Frame
No Side Stringers.
Construction in way of Solid Floors (4' 8" apart)
Intermediate Construction between Floors.
Ceiling

SECTION THROUGH THE CORRUGATED HULL OF THE STEAMSHIP "MONITORIA."

It appears evident that the principal difference lies in the residuary resistance which, in the plain ship, is 251 HP. and in column 4 for the corrugated ship under the same speed and displacement is 166 HP. a difference of nearly 34%, or taking the skin and residuary resistance together, a reduction of over 14½%. There are various theories to account for the improvement indicated. They may all have a part in the reduction of horse-power, but the principal one, in the writer's opinion, is that which treats of the amplitude of the wave. The large bow and stern waves seen on all full cargo vessels can only be formed by an expenditure of vertical force robbed from the propelling force which really lifts the ship by altering the trim.

The corrugations prevent the bow wave from attaining the amplitude usually attained in a plain-shaped vessel and give a greater speed of wave along the vessel's side, thereby washing out the eddy formation at the stern and thus reducing the amplitude of the stern wave. This greater freedom of water passing the stern also permits the under body stream lines to act more freely and favorably. The water passing the propeller and rudder is therefore less churned up, the usual eddies behind the ship are practically removed, and the propeller is fed by water less oblique and more solid, giving improved conditions in the reduction of propeller slip.

Bilge keels have been provided on the "Monitoria" like those of her sister ships, not that it was considered necessary, except in light ship, but because of the possibility of critics attributing the reduction in horse-power to the reduced frictional resistance due to the suppression of them. The corrugations can be considered as improved bilge keels, as they do their work whilst adding the other advantages previously enumerated. Their action along the vessel's side is to reduce the usual broken water and create a more smooth, clear and even flow of wave surface. It has been found on active service that she is more than usually quick on her helm, with no sheering to windward in a seaway. This is to be expected because the eddy action is reduced, giving a better flow into the propeller and past the rudder. Going against a strong wind and sea, 45° on the bow, the ship showed she could be kept on a straight course and acted with very easy movements, her more favorable behavior justifying her captain in forcing her quite one knot additional to the speed to that which in an ordinary type of ship he would have considered safe.

As regards plunging, this was also found to be much easier, due, no doubt, to the same reason as reduces the lateral period of roll. The waves at the fore end appear to be partially crushed to pass aft more freely and subsequently turn over, thus indicating less bow resistance to the vessel's progress. In a beam sea the back wash of one wave meets the succeeding one, and, taking the top off, robs it of part of its force and prevents it coming on board. The reduced commotion at the stern permits of a clear view of the propeller, and the ship's wake, which ordinarily is greater than the beam, is reduced to only half the width, being smooth and clear, with no following wave. This is remarkable in a vessel whose block coefficient is nearly .8.

DATA OF COMPARATIVE TESTS OF PLAIN SHIP AND THE CORRUGATED SHIP, "MONITORIA."

| | | Plain. | | | "Monitoria." | | | "Monitoria." | | | "Monitoria." | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Displacement | 4,450 | | | 4,575 | | | 4,575 | | | 4,450 | | |
| 2. | Wetted area | 17,435 | | | 17,730 | | | 17,730 | | | 17,480 | | |
| 3. | Knots speed | 9.78 | | | 9.78 | | | 10.07 | | | 9.78 | | |
| 4. | Revolutions per minute | 70.15 | | | 65.8 | | | 68.45 | | | 65.8 | | |
| 5. | Indicated horse-power | 1,116 | | | 1,005 | | | 1,116 | | | 986 | | |
| 6. | Indicated initial friction horse-power | | 85 | | | 80 | | | 83 | | | 80 | |
| 7. | Indicated load friction horse-power. | 157 | 72 | | 145 | 65 | | 156 | 73 | | 144 | 64 | |
| 8. | Power delivered to propeller | 959 | | | 860 | | | 960 | | | 842 | | |
| 9. | Efficiency of propeller, assumed | 70% | | | 70% | | | 70% | | | 70% | | |
| 10. | Thrust horse-power | 671 | | | 602 | | | 672 | | | 589 | | |
| 11. | Tow rope resistance, by experiment, to be overcome by propeller | 566 | 566 | | 494 | 494 | | 543 | 543 | | 482 | 482 | |
| 12. | Thrust deduction | 105 | | | 108 | | | 129 | | | 107 | | |
| 13. | Skin resistance power | | 315 | | | 320 | | | 348 | | | 316 | |
| 14. | Residuary horse-power | | 251 | | | 174 | | | 195 | | | 166 | |
| 15. | Propeller apparent slip | 9.43% | | | 3.67% | | | 4.46% | | | 3.67% | | |
| 16. | Initial friction & load HP. (line 6 &7 | 157 | | 28.5 | 145 | | 28.4 | 156 | | 27.2 | 144 | | 28.6 |
| 17. | Propeller friction (line 8—10) | 288 | 550 | 52.4 | 258 | 511 | 50.5 | 288 | 573 | 50.3 | 253 | 504 | 50.2 |
| 18. | Thrust loss (line 12) | 105 | | | 108 | | 21.1 | 129 | | 22.5 | 107 | | 21.2 |
| 19. | Skin friction horse-power (line 13) | 315 | | 55.6 | 174 | 494 | 35.3 | 348 | | 64.1 | 316 | | 65.6 |
| 20. | Residuary horse-power (line 14) | 251 | 566 | 44.4 | 320 | | 64.7 | 195 | 543 | 35.9 | 166 | 482 | 34.4 |
| | | 1,116 | | | 1,005 | | | 1,116 | | | 986 | | |
| 22. | Tons displacement carried at 10 knots with 100 I. HP. | 329 plain ship No 1 | | | 411=15.5% better carrier | | | | | | | | |
| | | 350 plain ship No. 2 | | | 411=17.4% better carrier | | | | | | | | |

A PERMANENT INTERNATIONAL ASSOCIATION OF Road Congresses was formed under the resolution adopted at the general assembly of the first Congress held at Paris in 1908. This association has for its object:

1. The organization of successive congresses.
2. The publication of sundry articles, reports and documents relating to roads.
3. The collection of the results found in every country from the tests of materials, used or suitable for use in the construction and maintenance of roads, obtained by application on the roads or by researches in the laboratory.

This Association, which has its headquarters 1 Avenue d'Jéna, Paris, is directed by a permanent international commission, composed of delegates from every country, having at its head a permanent council formed in the same way and a French Executive Committee.

It is thought that there are great advantages in a federation of all persons using the road or interested therein, because it will give the means of insuring equal facilities of circulation in all lands, and of becoming informed at all times about discoveries made in all parts of the world.

Every person belonging to the Association as a permanent member acquires the right, on the payment of 10 francs annual dues, to receive all the publications issued by the Executive Committee, to take part in all congresses, and especially in the second, which will be held at Brussels from July 31 to Aug. 7, 1910. However, every one joining the Association as a permanent member, during the year in which a congress is held, for instance, in 1910, pays for that year annual dues of 25 francs; for other years, the ordinary subscription is that of 10 francs, as aforesaid. Requests for membership must be sent to Mr. Mahieu, Secrétaire Général de l'Association, 1 Avenue d'Jéna, Paris, with the subscription of 25 francs for the year 1910.

## A Journal-Jack Block Slung from the Top of the Car Wheel.

The ordinary car-journal jack is supported on the ties or roadbed when in use and there is generally more or less settling of the jack base or block. A further difficulty is encountered in the occasional shifting of the wheel, while the journal is being raised, in such a way as to cramp the end of the axle in the box. A "swinging jack block" has been recently patented by Mr. W. A. Story and W. A. Hall, of Chillicothe, Ohio, which eliminates these difficulties by transmitting the load on the jack not directly to the roadbed or ties but to the top of the car wheel.

The construction of the swinging jack block is indicated in Fig. 1, which shows the block and jack in use. Two chains of steel eye-rods, three rods, or links, in each chain, are attached to heavy staples in the ends of the block. The other end of each chain carries a forged steel hook designed to fit over the flange of a car wheel. In use the chains are passed up from beneath between the journal box and the outer face of the wheel, one chain on each side of the axle. The two hooks are then applied to the top of the wheel at a distance apart slightly greater than the length of the jack block and are kept from slipping further apart by a short chain which is hooked together after the flange hooks are in position.

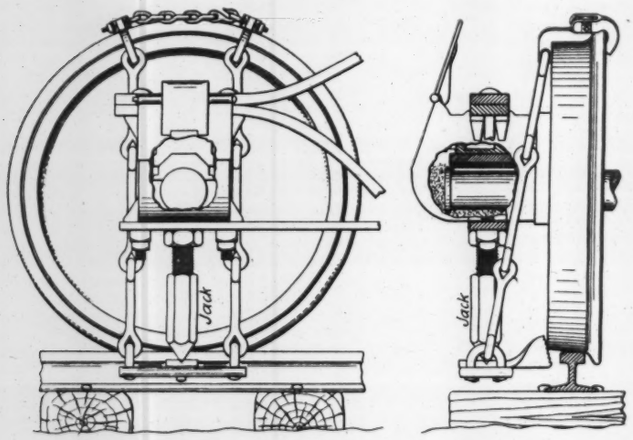



FIG. 1. SWINGING JACK BLOCK IN POSITION FOR USE ON A CAR JOURNAL.

(Weight of block and chains complete, without jack, is 45 lbs. Patented July 27, 1909.)

Fig. 2. Journal Jack Used in Connection With the Swinging Jack Block.

(Weight, 12 lbs. Diameter of screw, 2 ins. Rated capacity, 20 tons. Patented May 29, 1906.)

The length of the eye-rod chains is such that the jack block hangs at a convenient distance below the journal, and the block is held out away from the wheel by a toothed prop bolted to the upper side of the block and at right angles to it. This brings the block directly below the center of the load to be lifted and thus makes it certain that the box will be raised squarely from the journal.

The prop is made of tool steel and its stem, where it is bolted to the jack block, has a saucer-shaped depression which serves as a socket for the lower end, or point, of the jack. The jack for which the swinging block was especially designed is the "Hercules" journal jack, patented about four years ago by the same inventors. This jack is of the simplest possible construction. It has only two parts, a screw, or bolt, and a sleeve nut, or socket. The head of the bolt is roughened to give a secure bearing on the load; and the lower end of the prolonged nut is closed and has a conical point, rounded and hardened at the apex, which turns in the socket on the jack block. The jack is operated by turning the hexagonal sleeve nut with a long-handled end wrench. A photo of the jack is reproduced in Fig. 2 for the convenience of those not already familiar with its construction.

The swinging jack block is already in use, according to its makers (Story & Hall, Chillicothe, Ohio), on six trunk railway lines and has given satisfaction on the heaviest of cars and under the most trying conditions.

## Failure of a Reinforced-Concrete Circular Tank in New South Wales.*

On Jan. 22, 1909, the service reservoir at Mittagong totally collapsed at about 4.40 p. m.

This reservoir was of 40 ft. internal diameter, 40 ft. deep to top water level, 41 ft. deep to top; capacity, 314,000 gals. The shell was of reinforced concrete, 4½ ins. thick under coping, 10½ ins. thick at the bottom, including ½-in. of rendering on the inside, and ¼-in. on the outer surface.

The shell, including also a ring 5 ft. wide, 9 ins. thick all round the bottom, was specified to be constructed of a 1:2:2 concrete with ¼ to ¾-in. stone and the portion of the bottom inside the 5-ft. ring was specified to be of 1:3.25:5.42 concrete with ½ to 2-in. stone.

The reinforcement consisted of circumferential steel rods varying in size from ¼-in. at the top to 1 in. at the bottom and with spacings of 3 and 4 ins. c. to c. These were lapped 12 ins. for the smaller rods at the top up to 40 ins. for those at the bottom. The vertical rods were ¼-in., with 10-in. laps.† The rods were tied at all intersections with No. 16 black wire.

The steel was specified to have an ultimate strength of from 56,000 to 67,000 lbs. per sq. in., with an elongation of 20% in 8 ins., and an elastic limit of not less than 50% of the ultimate strength.

UNIT STRESSES.—In designing the shell no allowance was made for any tension in the concrete, it being assumed that the steel rods would take the whole of the tensile stress due to water pressure. Under these conditions the tension per square inch in the steel rods was as follows:

| | Due to full head of 40 ft., lbs. | Due to 32 ft. head. Depth at failure, lbs. |
|---|---|---|
| At floor level | 15,900 | 12,750 |
| At 10 ft. above floor | 15,700 | 11,400 |
| At 20 ft. above floor | 14,100 | 8,525 |
| At 30 ft. above floor | 15,900 | 3,140 |

In designing the joints, it was assumed that there would be adhesion between the steel and the concrete for the full diameter of rods and length of lap. Under these conditions the adhesion at the joints per square inch was as follows:

| | Due to full head of 40 ft., lbs. | Due to 32 ft. head. Depth at failure, lbs. |
|---|---|---|
| At floor level | 100 | 80 |
| At 10 ft. above floor | 96 | 74 |
| At 20 ft. above floor | 83 | 50 |
| At 30 ft. above floor | 83 | 17 |

APPEARANCE OF RESERVOIR AFTER FAILURE.—From a careful examination made immediately after the failure, it would appear that the reservoir failed all round simultaneously, or almost so, and that the upper half then fell upon the foundation and crumpled over. A portion of the upper section of the shell, about 18 ft. 6 ins. in height, was found standing nearly vertical upon the foundation, but of the lower half of the reservoir only a few small sections remained, showing the full thickness of the concrete with the rods embedded therein, as constructed. Practically the whole of the lower portion of the shell had split in halves along the line of the reinforcing rods, and the ground was strewn with pieces of concrete of the half thickness of the shell, and up to about 2 ft. × 2 ft. in dimensions. The rods, which were in most instances lying free of any concrete, had been thrown with force against trees, round which they were bent, or against the sides (6 ft. to 8 ft. high) of the old quarry in which the reservoir was built.

The largest piece of the bottom half which had not been entirely destroyed measured about 10 ft. × 8 ft., and was lying against the side of the excavation opposite to the 18-ft. 6-in. vertical upper section. This portion had been turned upside down, and the inside face was lying against the bank, thus demonstrating the great force with which it had been thrown out at the time of the failure.

PROBABLE CAUSES OF FAILURE.—An investigation was made by Messrs. Dare and Burrows as to the probable causes of failure, with a view of detecting: (1) Defects in design; (2) defects in material; (3) defective workmanship; and (4) other causes not included in the foregoing. With the results of this investigation before him, the Acting Chief Engineer for Rivers, Water Supply, and Drainage reported as follows:

Taking these headings seriatim, I am of opinion (1) that while the stresses allowed in the steel, amounting to 15,900 lbs., would appear to be justified by the authorities quoted in the appendix to Mr. Dare's report—that is to say, the British Reinforced Concrete Committee, the Prussian Government Regulations, the Swiss Society of Engineers and Architects, and the New York Municipality Regulations—such a stress is excessive, and should not exceed 12,000 lbs. in similar structures. I consider that, while the overlap in the horizontal rods was sufficient in accordance with modern practice, and the adhesion relied upon was fully justified by authorities, the position of the rods with regard to each other—they touching each other in a vertical plane—was such that the concrete could not cling around the whole diameter of the rod, and in this way the joint was greatly weakened, and the adhesion on which the strength of the reservoir depended was not developed. I am further of opinion that the use of a single grill of rods of considerable diameter placed vertically over each other at 3-in. intervals makes it difficult to ram the concrete between the rods in such a manner as to fully develop the adhesion, and forms a weak line centrally throughout the shell. I do not consider the design of the junction between the shell of the tank and the floor, to which Mr. Burrows has drawn attention, of much importance, the failure having occurred by the bursting of the reservoir as a ring, and the junction of the shell with the floor not being in any case relied upon to resist the bursting pressure.

2. I cannot find that the material used in the work was in any way defective; the full quantity of steel and cement required by the specification was undoubtedly used, and there was no tendency or attempt on the part of the contractors to "scamp" the work in regard to quantities or quality of material supplied by them. As to the cement, which was supplied by the Department to the contractors, it passed the specified tests, and although the time of finally setting is not very uniform, and the increment of strength between the seven days' and twenty-eight days' tests is low, I do not think that the failure can be attributed to inferior cement, especially taking into account the appearance of the concrete from the wrecked structure.

It is noticeable that in almost every case the cogs bent on the end of the rods have either sheared off or cracked in the bend. This would not be the cause of failure, but would follow upon it, as the cogs are not relied upon in the calculation to increase the strength. There is no doubt, moreover, that they were bent too short, and readily failed in consequence.

3. With regard to the workmanship, I am of opinion that defective packing in portions of the work was the chief cause of failure, and I attribute this partly to the concrete having been used too dry in places and partly to the difficulty to which I have already referred of packing it between the bars. I do not consider that the contractors or their employees or our Inspector were wilfully careless with regard to this packing, or refrained from packing the concrete in a proper manner with a view to saving time or trouble. On the only occasion on which I personally visited the works, concrete was not being actually placed, but I saw nothing in connection with the work to which I could take exception. I am of opinion that the Inspector used every diligence, so far as his experience guided him, to have the work done in a proper manner, and did not suspect what we now know to be the case, that the concrete was not effecting a good junction between the various bars of the grill. The contractors constructed the Katoomba and the Port Kembla tanks on similar principles, and we have had no trouble with them; further, a tank of precisely similar design to this at Mittagong has just been constructed at Gunnedah, and in this case no trouble has developed.

4. As to other causes of failure than the above, the great distance to which the fragments of the tank were thrown and the small size of those fragments produced an impression upon many persons who saw it that the wreck of the tank had been the result of an explosion. There is no doubt, however, that, admitting the failure by bursting of the bottom rings of the tank, the force of the water would be amply sufficient to produce the effects observed. At the same time I must express surprise at the extraordinarily uniform nature of the failure, the fragments being scattered almost equally in every direction. The idea of the failure being due to such cause as an explosion or lightning may be put on one side.

Apart from the causes to which I have referred above, it is a matter for consideration if the subjecting of the tank to pressure only 98 days after its completion attributed to the failure. From an inspection of the fragments, I formed the opinion that portions of the concrete were much too green to have developed anything like the full adhesion to the steel grill, and that the work would have been much better if left to stand for a

*From Report of the Department of Public Works of New South Wales for the year ended June 30, 1909.

†Spacing not given.—Ed. Eng. News.

further period before being subjected to strain. I am not, however, inclined to attach too much importance to this aspect of the case, as I think the defects in adhesion due to the difficulty of packing the concrete round the bars were in themselves sufficient to cause the failure.

### Tests Made to Determine the Adhesion Between Rods and Concrete.

Since the failure of the reservoir, some tests have been made at the Sydney University by Prof. Warren to determine the adhesion between the steel rods and the concrete in which they were embedded. The steel rods used in these tests were cut from some of the rods taken from the wreck.

The concrete was of similar composition to that used in the Mittagong Reservoir, and was mixed with about 14% of water.

[These tests were made on rods embedded lengthwise in concrete blocks 9 × 9 × 142 ins. in size. In specimens A and B the rods were lapped side by side and the end of each was turned up in a short vertical hook away from the other rod, leaving a space of about 1 in. from the end of each hook to the outside of the block. In Specimen C the rods were plain rounds, with no hooks, and overlapped each other 40 ins., thus leaving a 1-in. space at the end of each rod. In Specimen D the rods were held apart during the filling of the molds by cement pats about 3-in. cubes so that adhesion obtained around the whole surface of the rod.—Ed. Eng. News.]

Description.

| | Age when tested. | Length of rods in concrete, ins. | Diameter of rods, ins. | Area super. of rods, sq. ins. | Total load at failure, lbs. | Load per inch super. at failure. | | Remarks. |
|---|---|---|---|---|---|---|---|---|
| A | 98 days | 41 | 1 | 128.8 | 37,450 | 290.8 | ..... | Hook broke, and bar drew<br>Concrete split other end |
| | 6 months | 41 | 1 | 128.8 | 38,100 | 295.8 | First crack at 25,050 lbs. | Hook broke, and bar drew<br>Concrete split other end |
| B | 98 days | 37 | ⅞ | 101.7 | 21,750 | 213.9 | First crack at 15,000 lbs. | Hook intact, and bar drew<br>Concrete split other end |
| | 6 months | 37 | ⅞ | 101.7 | 27,700 | 272.4 | ..... | Hook intact, and bar drew<br>Concrete split other end |
| | 98 days | 41 | 1 | 128.8 | 28,650 | 222.4 | First crack at 26,000 lbs. | Rod pulled out. |
| | 98 days | 41 | 1 | 128.8 | 30,800 | 239.1 | First crack at 25,000 lbs. | Rod pulled out.<br>Concrete split both ends. |

Composition of the concrete: One cement; two sand; two broken blue-stone.

It will be seen from the above that, neglecting the assistance due to the hooked ends, the average adhesive stress between the rods and the concrete was 256 lbs. per sq. in., or, allowing for adhesion round the whole circumference of the rods, about 3.2 times the maximum stress in the rods of the reservoir, when failure took place. This figure represents the theoretical factor of safety for adhesion of the joints of the rods, but some reduction would need to be made owing to the fact that the rods were in contact at the joints, and also on account of the more favorable conditions under which the test specimens were made.

## The Cooperative System of Industrial Education.*

For two years past the undersigned has, supplemental to the report of the Committee on Industrial Education, made a report dealing with the establishment and progress of the cooperative course as planned by Prof. Herman Schneider, Dean of the Engineering College of the University of Cincinnati.

It will be remembered that this course provides a method whereby the student is at the same time an apprentice in a manufacturing establishment during the period of his attendance at the university. This provision is accomplished by arranging to employ the students in pairs, one of whom is at the university during one week while his alternate is at the shop, and the following week reversing the positions, the one at the shop going to the university and the one at the university working in the shop. This course is now in its fourth year of successful operation. Its growth has been most gratifying, both to the university and the manufacturers of Cincinnati.

The first year barely enough students could be interested to start the course. The second year approximately 800 inquiries and applications were received at the university, from whom 60 students were selected to go into the course. The third year over 2,000 inquiries and applications were received, from whom about 80 students were selected. Last summer, the beginning of the fourth year, over 3,000 inquiries and applications were received, from whom 75 students were selected, this being the maximum number possible to accommodate at the university. This year, with increased facilities at the university, judging from the present rate of inquiries, we shall have from 4,000 to 5,000 inquiries to select from and will take on possibly 125.

The capacity of the course has been limited by the university's facilities. The manufacturers who at first, with few exceptions, looked upon the plan with grave doubt, have been converted to its merits and will to-day give places to as many students as the university can take care of. The experience of the manufacturers is that the present cooperative students who have been at the university for four years are of more value to their employers than the ordinary college graduate who has had four years' work in college and two or three years' special apprenticeship after his college course. The experience of the university is that the cooperative student accomplishes more work in his college course in half time than the ordinary student does in full time.

The ability and character of the students entering this course is remarkably high. This is only what could be expected when one considers the large number of applicants we have to select from. We get none of the kind of students that are "sent" to college by their fond and doting parents. Ours are the kind that "come" to college of their own accord, hungry for knowledge. Most of them would never have been able to get a college course under any other scheme. They earn about $2,000 during their course at Cincinnati, which goes far to carry them through. We have no time-wasters, as shown by the fact that in three years there has not been a single case among the cooperative students requiring disciplinary action on the part of the faculty. They are there for business; they are using every minute at their disposal to acquire knowledge that will fit them for directive positions in mechanical, electrical, chemical and civil engineering positions. There are now some one hundred shops cooperating with the university in the training of these young men. The employers of the first class, now four years along, would place these students in positions of responsibility right now were it not for the fact that the shops had agreed with the university on a six-year course.

A new departure in the course will be made beginning the summer of 1911. The course was originally laid out to take six years of school and shop, eight and one-half months of each year being at half-time work at college, with full shop time during the summer in addition to the half-time shop work during the school months. But the progress of the students has been so rapid both in the shop and school that the time can, with advantage, be reduced to five years of half-time work straight through each year. Therefore commencing with the year 1910-11, a schedule will be arranged for the university's Engineering College to operate eleven months in the year on half time, the month of August to be devoted to vacation by the faculty and the students to alternate for half the month of August on vacation. This will leave the shops fully manned throughout the year without the necessity of doubling the number of students in the shops during the summer as heretofore.

Commencing with the present year the cooperative system was extended to the civil engineering course, in which it had been difficult to arrange a plan before now. At present arrangements are in effect whereby the students work in bridge and structural work in alternate weeks for a certain length of time. In cooperation with the Union Pacific Ry. Co., we also have an arrangement whereby the students are taken for instruction during the summers on railroad work. The Union Pacific authorities have arranged a scheme to handle our students that is entirely different from the summer jobs open on that system to the students of other institutions. This scheme goes into effect the coming summer. It is a great compliment to Dean Schneider and his methods that the Union Pacific authorities should pick out his students for this special arrangement. In addition to the civil engineering course established this year the coming session will witness the establishment of a metallurgical course in cooperation with foundries, rolling mills, steel works and blast furnaces within easy reach of our city.

Furthermore, we have under consideration plans for the establishment of a College of Commerce on the cooperative plan, the idea being that young men, high school graduates, shall work in office and mercantile positions half time either alternate weeks or alternate quarters, as it will be found desirable and possible. The latest institution to adopt the cooperative system is the University of Pittsburg, which we are informed by the Board of Trustees has decided to establish a course similar to ours. Pittsburg offers a magnificent field for cooperative courses, with its large and varied industries and their demand for men trained in the higher technology, particularly for directive and supervisory positions. There is no doubt that the University of Pittsburg, with the proper faculty, will be able to take a commanding position in engineering education. We feel that it is only a question of time when every institution will see the value of this course, particularly so when the employers of technical graduates will hammer into the collegiate authorities the necessity of practical as well as theoretical training of engineers.

We believe that the main value of our cooperative course is for producing engineers such as we are making, and lies in their intimate contact as apprentices with all classes of workmen, resulting in an appreciation of the workmen's difficulties as well as their point of view. This contact will go far when our young engineers are in positions of authority to eliminate friction between workmen and managers. Friction often comes from such a lack of appreciation by supervisors who have never been intimately associated with workmen as such. We also feel, as stated in previous reports, that a great field for the cooperative graduate will be found in the teaching corps of other institutions of all grades, from the colleges down.

It takes practical men to teach practical work to practical boys. The purely school-trained teacher is even to-day a failure in manual training. It is safe to say that much so-called manual training as now conducted is merely a schoolmaster's fad, culturized to a point of folly. Manual training teachers have wasted thousands of dollars in ridiculous equipment in the manual training departments of the public schools without interesting boys in industrial work.

The average youngster likes the manual training class, but it is a pity that the schoolmaster's notions prevent the boy from getting more value from manual training than is now usually the case. In Massachusetts the Fitchburg High School's course, modeled along Cincinnati lines, is an unqualified success. Mr. Hunter, the director of the school, at the recent convention of the National Metal Trades Association, quoted statements made by the students direct to one of the Fitchburg papers, showing that this school is working with all the benefit that can possibly be expected and to much greater advantage than any merely manual-training high-school course could work. We have reports of many other institutions falling into line with the cooperative idea. As stated in the writer's report to the Association on previous occasions, we think the cooperative system is bound to win its way, because it is right and practical and gives the boy and the employer something better than they have ever had before, whether it be in high school or collegiate work.

### The Continuation School.

And now I come to a further development of industrial education in Cincinnati, the Continuation School.

This school was started originally as a private apprentice school, conducted by some of the machinery manufacturers for their apprentices. It was found that the ordinary apprentice boy, coming into a shop to learn the trade, was of the sort who had lost interest in the dry-as-dust methods of the ordinary school room and that after leaving it at an early age, either as soon as the law allowed or even before, his training was practically useless to him in the shop. Even what he did receive had been so uninteresting to him as to be a bore rather than a benefit.

To correct the deficiencies of the early training of their boys two of the broad-minded members of this Association, the Houston, Stanwood & Gamble Co. and the Cincinnati Milling Machine Co., started an apprentice school under the direction of a young instructor who had himself been a machinist, Mr. J. H. Renshaw. Mr. Renshaw from his practical experience has developed new methods of instruction, entirely different from anything that has heretofore been used by school teachers. He teaches the boys spelling and reading from catalogs. He teaches them arithmetic, geometry, algebra and trigonometry from machine parts. He teaches them composition by having them write essays on spoiled work. He teaches them business by figuring pay-rolls and costs, all of which is done to make the ordinary apprentice a better mechanic and give him a fair appreciation of his trade. The Continuation School deals with the ordinary boy who comes to the shop sometimes with as little schooling as he would get by going through the second grade. The average schooling of the boys in the Continuation School would correspond to that received in the sixth grade by a child of twelve. With this kind of material in a very short while Mr. Renshaw and his methods have done wonders. He teaches trigonometry to a boy whose education stopped at twelve, but it is taught not as trigonometry but as shop problems of every-day value.

Mr. Renshaw's success was so great in the two private

*A report made to the Annual Meeting of the National Association of Manufacturers, New York, May 16-18, to which are appended portions of an announcement by the Secretary of the University of Pittsburg.

schools that other manufacturers were interested in his methods. A committee of the Cincinnati Metal Trades Association called upon the School Board and asked that a Continuation School be started to which all the machine shop apprentices should be sent. The plan was laid out by Mr. Renshaw and the school was turned over to the School Board. His methods are revolutionizing the teaching of all those subjects in the other schools. The school has nine sessions a week of four hours each. The shops send their apprentices for one session, or one-half day a week, arranging the time to suit the convenience of the shop, so that all of the boys are not in school at the same time. The boys are given a half-day's pay for the time they spend in school. If they come late to school, they are heavily docked, so that in addition to their interest their pocketbook is a great influence to regular and prompt attendance.

This school runs all the year, the instructors taking their vacations at convenient times during the year and the school itself being a half-day's vacation every week for every working boy in it. The morning session begins at 7.30 and lasts until 11.30, giving the apprentices chance to get to school on time and to get their dinners and get to the shops on starting time in the afternoon. The afternoon session begins at 1.30 and lasts until 5.30. There are now about 275 boys enrolled so far, with the number increasing every week. Each of the instructors in the school must spend one day a week in the shops, picking out the practical problems dealing with the boys' every-day work. A tremendous fund of teaching material is thus gathered and utilized.

It is expected that as soon as new accommodations can be arranged for the school next fall will have 500 boys from the machine shops alone. Manufacturers in other lines becoming interested asked the Superintendent of Schools why they could not have a Continuation School for their boys. They were promptly told they could as soon as they would furnish enough boys to start a class; the School Board would provide facilities and instructors and would do for any line what the present force is doing for the machinery line.

A girls' Continuation School will be started the coming fall for department store clerks and for girls employed in millinery, shoe and cloth factories. It appears that Cincinnati has the first and only public Continuation School in the world, and here, too, we hope our example will be followed elsewhere. This year's Ohio Legislature has passed a bill, long needed, whereby school attendance is compulsory up to the age of sixteen, except that children between fourteen and sixteen may take employment under school certificates, but if they are not at work they must be at school. The result of this bill will be to increase the demand for continuation work. It will not be surprising if the attendance at the Continuation Schools will in a short time amount to 5,000 children, giving them something of practical value to help them along in their life's work. Perhaps the greatest value of the Continuation School in the long run will be its influence in modifying the courses in the regular schools, so that the children will be more interested in school work, giving them practical problems, for instance, in arithmetic, and eliminating the dry-as-dust methods that are everywhere too prevalent.

The opening of two new high-school buildings, now nearing completion, will give us the cooperative course in our high schools as well as in the university, so that in the course of a few years a Cincinnati child will have every opportunity in Cincinnati's tax-supported institutions to receive a definite and practical industrial education to fit it for any position for which it is mentally and physically capable. The Continuation School will take care of the ordinary mechanic and give him what he needs to know to thoroughly understand his trade. The cooperative high school course with its apprenticeship will fit the boys for minor positions of responsibility and the engineering and commercial courses at the university will fit the young men for the higher positions demanding a higher grade of education. All these things are done through the cooperative system at a minimum of expense—the school teaching the school work, and the shop teaching shop work, under commercial conditions.

The school is not put to the expense of purchasing equipment that soon becomes antiquated and useless for instructional purposes. Neither will the school be turning out unfinished mechanics, as the so-called trade school is almost bound to do. The influence of the shops on the schools is all for good and the corresponding influence of the right kind of school teachers on the foremen of the shops is also all for good. Both working in harmony, each learning from the other, we are convinced that in ten years, due to these educational methods, Cincinnati will be unsurpassed as an industrial center.

To those interested, we give you a hearty invitation to come to Cincinnati to investigate any of these methods, and we assure you a hearty welcome in the shops and in the schools, and we believe that the most valuable assistance we can give you is to get others to "Go and do likewise." Respectfully submitted,

E. F. Du Brul.

[Details of the courses arranged by the University of Pittsburg as mentioned in Mr. Du Brul's report are not at hand. The following paragraphs from the report of the Committee of the School of Engineering to the Board of Trustees shows in general the plan to be placed in operation in October next.—Ed.]

The engineering schools and the companies who employ their graduates are working independently in their efforts to prepare young men for entrance upon their life's work. Since both school and future employer have the common aim to fit the young man for efficient service at the minimum of cost in time and money, it is evident that the best results cannot be had by independent action but by cooperation.

The University of Pittsburg because of its splendid industrial environment is most favorably situated to apply this cooperative principle to the education of young men who are preparing to enter the engineering industries. Instead of keeping the young man away from the actualities of his life's work for a period of four or more years prior to graduation, as is the general custom of engineering schools, the Committee on the School of Engineering have matured a cooperative plan whereby the student, while spending in school the amount of time usually devoted to instruction in our best engineering institutions will work four terms of three months each, in the engineering industries of the Pittsburg district. By this plan the student gets the usual theoretical course and in addition twelve months of practical work, all in the space of four years, the school work being arranged so that successive groups of students will furnish continuous service to the employer.

Courses in Civil, Mechanical, Electrical, Chemical, and Sanitary Engineering are offered by the School of Engineering of the University and in all of these there is incorporated the principle of cooperation. These five courses are arranged so as to be identical for the first three terms. This permits of developing the student to a certain extent along lines which are common to all engineering before requiring him to choose the specific course he is to pursue. These first three terms are looked upon as a probationary period in the sense that the nature of the work done by any particular student during this period will determine in the judgment of the faculty whether or not he is to be advised to continue in the School of Engineering.

While the University has made special arrangements with a number of our local concerns for the benefit of its engineering students and will cooperate with the management of these concerns in every way possible, yet the student will be considered as a direct employee of the concern. He will serve as a regular employee for six regulation working days each week for which he will receive the regular wages of a student apprentice, and will be expected to observe strictly the rules and regulations of the company and will work under existing labor laws and conditions including those pertaining to liability for accidents. This industrial practice will be arranged so that the student will have an opportunity, as far as practicable, to engage in work pertaining to any phase of engineering in which he may be particularly interested.

The student will report to the proper instructor at the University one evening each alternate week for discussion of the work being done; and at the end of the term he will receive 20 credits when a written report of his work and observations during the term has been received and accepted by the instructor in charge.

This work will be conducted under actual commercial conditions and will cover four terms of three months each, distributed through the middle of the student's course at the University.

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THE STUDY OF WASTE PRODUCTS, rare elements and special compounds, which are often put aside as capable of impracticable utilization, is urged by a special committee of the Divisions of Industrial Chemists, American Chemical Society. This committee is composed of Messrs. W. R. Whitney, General Electric Co., Research Laboratory, Schenectady; M. C. Whittaker, Columbia University, New York City, and Gellert Alleman (chairman) Swarthmore, Penn. This body hopes to act as a clearing house between manufacturer and consumer and asks for suggestions regarding the scope of investigations to be undertaken. The first step planned for cooperation between manufacturers and investigator is the securing of knowledge about the availability of the various substances and uses which may be made of them. It is proposed to publish a list of availability of the chemical elements with prices. Later novel or newly available compounds would be added.

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## Standard Specifications for Concrete Reinforcement Bars Adopted by the Association of American Steel Manufacturers.

The Association of American Steel Manufacturers have just announced the formal adoption by letter ballot of a standard specification for concrete reinforcing bars. Coming as it does from the authoritative body on steel manufacture this specification is of peculiar value. It may be procured from the Secretary of the Association, Mr. Jesse J. Shuman, Jones & Laughlin Steel Co., Pittsburg, Pa.

The specification is as follows:

STANDARD SPECIFICATIONS FOR CONCRETE REINFORCEMENT BARS.
Adopted 1910.

MANUFACTURE.

1. Steel may be made by either the open-hearth or Bessemer process. Bars shall be rolled from billets.

CHEMICAL AND PHYSICAL PROPERTIES.

2. The chemical and physical properties shall conform to the following limits: [See accompanying table.—Ed.]

| Properties considered. | Structural steel grade. Plain bars. | Structural steel grade. Deformed bars. | Hard grade. Plain bars. | Hard grade. Deformed bars. | Hard grade. Cold twisted bars. |
|---|---|---|---|---|---|
| Phosphorus, maximum: | | | | | |
| Bessemer | .10 | .10 | .10 | .10 | .10 |
| Open-hearth | .06 | .06 | .06 | .06 | .06 |
| Ultimate tensile strength, lbs. per sq. in. | 55,000-70,000 | 55,000-70,000 | 80,000 min | 80,000 min | Recorded only |
| Yield Point, minimum, lbs. per sq. in. | 33,000 | 33,000 | 50,000 | 50,000 | 55,000 |
| Elongation, per cent. in 8-in., minimum | 1,400,000 / T. S.* | 1,250,000 / T. S. | 1,200,000 / T. S. | 1,000,000 / T. S. | 5% |
| Cold bend without fracture: | | | | | |
| Bars under ¾-in. in diameter or thickness | 180° d.=1t. | 180° d.=1t. | 180°d.=3t. | 180°d.=4t. | 180° d.=2t. |
| Bars ¾-in. in diameter or thickness and over. | 180° d.=1t. | 180° d.=2t. | 90°d.=3t. | 90°d.=4t. | 180° d.=3t. |

*T. S. = tensile strength.
The hard grade will be used only when specified.

CHEMICAL DETERMINATIONS.

3. In order to determine if the material conforms to the chemical limitations prescribed in paragraph 2 herein, analysis shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt or blow of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector.

YIELD POINT.

4. For the purposes of these specifications, the yield point shall be determined by careful observation of the drop of the beam of the testing machine, or by other equally accurate method.

FORM OF SPECIMENS.

5. (a) Tensile and bending test specimens may be cut from the bars as rolled, but tensile and bending test specimens of deformed bars may be planed or turned for a length of at least 9 ins. if deemed necessary by the manufacturer in order to obtain uniform cross-section.

(b) Tensile and bending test specimens of cold-twisted bars shall be cut from the bars after twisting, and shall be tested in full size without further treatment, unless otherwise specified as in (c), in which case the conditions therein stipulated shall govern.

(c) If it is desired that the testing and acceptance for cold-twisted bars be made upon the hot rolled bars before being twisted, the hot rolled bars shall meet the requirements of the structural steel grade for plain bars shown in this specification.

NUMBER OF TESTS.

6. At least one tensile and one bending test shall be made from each melt of open-hearth steel rolled, and from each blow or lot of ten tons of Bessemer steel rolled. In case bars differing ⅜-in. and more in diameter or thickness are rolled from one melt or blow, a test shall be made from the thickest and thinnest material rolled. Should either of these test specimens develop flaws, or should the tensile test specimen break outside of the middle third of its gaged length, it may be discarded and another test specimen substituted therefor. In case a tensile test specimen does not meet the specifications, an additional test may be made.

(d) The bending test may be made by pressure or by light blows.

MODIFICATIONS IN ELONGATION FOR THIN AND THICK MATERIAL.

7. For bars less than 7/16-in. and more than ¾-in. nominal diameter or thickness, the following modifications shall be made in the requirements for elongation:

(e) For each increase of ⅛-in. in diameter or thickness above ¾-in. a deduction of 1 shall be made from the specified percentage of elongation.

(f) For each decrease of 1/16-in. in diameter or thickness below 7/16-in., a deduction of 1 shall be made from the specified percentage of elongation.

(g) The above modifications in elongation shall not apply to cold-twisted bars.

NUMBER OF TWISTS.

8. Cold-twisted bars shall be twisted cold with one complete twist in a length equal to not more than 12 times the thickness of the bar.

FINISH.

9. Material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

VARIATION IN WEIGHT.

10. Bars for reinforcement are subject to rejection if the actual weight of any lot varies more than 5% over or under the theoretical weight of that lot.

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The present tendency away from the steam engine drive for rolling mills should call out vigorous efforts for improvement in the design of rolling-mill engines. One such improvement, developed recently in Germany, is described elsewhere in this issue.

Enthusiasm over newly developed types of prime movers is not unlikely to lead to their adoption under operating conditions which could be better met by the reciprocating steam engine. Interest is aroused by remarkable results obtained, in notable instances, with particular installations of electrical machinery, gas engines or exhaust-steam turbines. This interest, enhanced by the novelty of the newer drives, distracts attention from the possibility of improvements in the older form of motive power.

Closely connected with this tendency is that of ascribing too much importance to fuel economy alone. Economy in fuel consumption under the most favorable operating conditions is of relatively small importance when such conditions do not obtain in actual use. In fact, fuel economy is not infrequently altogether subordinate to other considerations—such as first cost, convenient control, reliability and cost of maintenance; and with a low load factor, the operating expense may be far outweighed by the fixed charges. Perhaps the commonest opportunity for error is in forgetting that power systems, preeminently successful in certain very large installations, may be quite unsuitable and inferior for smaller plants.

In recent years, electric motors have come into use for driving rolling mills, especially in connection with the generation of electric power with large gas-engine units, where blast-furnace gas is available for fuel. Advantages over the steam-engine drive are claimed in fuel economy, convenience of control and ability to start and reverse more quickly. Even more recently, the exhaust-steam turbine has been used as a rolling-mill drive, in combination with the reciprocating engine, with the idea of reducing the steam consumption.

Probably the chief reason for discarding the steam engine as a rolling-mill drive is its extremely poor average thermal efficiency. The engine has to be made large enough to meet the sudden load put upon it when the ingot first enters the mill, and consequently most of the work is done at much less than the full-load capacity. This condition is, of course, unavoidable, but not so another and more important cause of low efficiency. The speed control, or power regulation, of the reversing rolling-mill engine is effected, in actual operation, by throttling. If this could be changed and the engine controlled by varying the cut-off, a material improvement in economy would be the natural result.

The article in this issue by Mr. Edward G. Sehmer and Dr. R. Drawe, both of Saarbrücken, Germany, includes a description of a single-lever, cut-off control which is now in successful use, in Germany, on reversing rolling-mill engines. Besides decreasing the steam consumption, the new system has the added advantage of being simpler for the operator to manage than the usual arrangement of throttle and reverse levers. The authors of the above mentioned paper maintain, on the basis of recent tests made by the (German) Commission on Power Requirements of Rolling Mills, that the modern steam engine, especially when equipped with the new system of control, is superior to any other reversing rolling-mill drive.

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A water intake composed of well strainers driven upward from a tunnel under the bed of a river is a novel piece of work which was described in our issue of June 9. The intake is to supply condensing water to a power station, but probably there are conditions where the system might be applied to other purposes. The method of placing the intake pipes, by forcing them through a thin shell of rock left at the end of the tunnel, was a bold one and necessitated careful measurements and work to ensure the successful results which were obtained. Experiments were made with the strainers extending only into the mud and silt of the river bed, and also with them extended so as to stand in the main body of water, and there appeared to be less clogging of the strainers in the former position. They are all arranged, however, for cleaning the strainers by blowing them out with compressed air. While the job was a comparatively small one it presents features of interest which make it specially worthy of note. In this connection we would call the attention of our readers to the fact that details of special work or methods of this kind are of exceptional interest and value to our readers, more so, in many cases, than extended descriptions of work of a more ordinary character. When an engineer devises and carries out work by such special methods to meet special conditions, he can render the profession good service by making his experience public through the columns of Engineering News.

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In the city of San Francisco there is at present a decided public agitation in favor of the construction of a tunnel for foot-passengers, vehicles and street cars under one of the main streets of Nob Hill. The tunnel, under Stockton St., from Bush to California St., is to be 750 ft. long with two open cut approaches each 250 ft. long. It is designed for the whole street width with the usual roadway and sidewalk sections and will cut down a very heavy grade over the edge of the hill to easy 2 or 3% slopes.

While there are only a few cities in the country where the topographical conditions demand and allow such a structure or where it is economically justified, there have been one or two instances, notably in Los Angeles, where similar tunnels have proved successful. So the San Francisco proposal, as an engineering project, is not unique. The proposed method of financing the San Francisco tunnel, however, is quite likely to lead to some difficulties, and seems hardly fair. According to press dispatches, the expense of the construction, estimated at about $500,000, is to be defrayed by an assessment of $2.25 per front foot on the property of a special district embracing about 80 contiguous blocks.

Possibly there may be no objection on the part of the assessed owners in the special district to the payment of this sum, but is it not too broad an application of the local assessment principle? The benefits to be derived from the tunnel may accrue more to the adjacent property than to outlying districts, but the reduction of grade from one part of a city to another is a benefit to the city as a whole and unless in a location confined solely to a restricted and local traffic, should really be borne, partly at least, by the city at large. If a uniform assessment over a given limited area is to be made, it is quite probable that the appraisers will find it difficult to delimit that area; if a graded rate is to be made there will be the same difficulty in specifying the extent and the amount of the beneficent influence of the tunnel.

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Technical societies in England appear to be subject to trials seldom experienced in this country. Thus, the awkwardly-named Incorporated Association of Municipal and County Engineers, on wishing to change its name to the slightly more convenient title Institution of Municipal and County Engineers experienced much trouble and delay before it could gain the approval of the Board of Trade. This was largely due to opposition on the part of the Institution of Civil Engineers, representatives of which objected that the natural abbreviation of the proposed new title would end with C. E. A conference between representatives of the two societies led to an agreement on the name Institution of County and Municipal Engineers, thus affording the termination M. E. instead of C. E. Some members of the minor society opposed the change because county engineers would rank before municipal engineers in the title. A legal point having been raised, the Board of Trade refused its sanction to use the proposed title. Subsequently a number of members labored assiduously with representatives of the Institution of Civil Engineers (one member devoting six days to the subject), and finally secured a withdrawal of the opposition of the older society. Assurances of approval by the Board of Trade have also been secured. The title, Institution of Municipal and County Engineers, was adopted at a general meeting of the association a few weeks ago.

Another thorn in the flesh of the Municipal and County Engineers has also been removed after having caused a sore for many years. This also required the consent of the Board of Trade, which was finally prevailed upon to allow the association to alter the very unhappy phrasing of the foot note which must appear on certain certificates granted by the association. These certificates are issued to persons who pass the examinations held periodically by the association to determine fitness for certain municipal offices. The old foot note read:

> This certificate shows the result of an examination held on behalf of the Association, and is not to be deemed a qualification to discharge the duties of any office or appointment.

The last half of this statement was subject to an interpretation which might render the certificate worthless. It has now been changed, by consent of the Board of Trade, to read:

> This certificate shows the result of an examination held on behalf of the association and is not issued under any Government authority or under the provisions of any charter or statute.

This seemingly simple change, it is reported in the London "Surveyor," "engaged the attention of the council (of the association) for many years. During that period "many interviews" with the Board of Trade were had, while to draft the amended note a solicitor was engaged. The change finally agreed to is considered as "half a loaf," since what the Association really wished was the complete elimination of the foot note.

We will not show our ignorance of British conditions by attempting to explain why a technical society should be so much under the control of the Board of Trade as this one seems to be, further than to state that the control seems to come through the fact that the society is incorporated.

After incorporation, of course any American

societies would have to secure permission from the proper state authority before changing either its name or its charter powers, but incorporation would rarely, if ever, subject an American technical society to state control over what seems to be so purely an internal matter as the granting of certificates to candidates who had passed examinations designed solely to test their fitness to perform certain municipal functions. But none of our technical societies have gone so far as to conduct such examinations. When they do, perhaps some degree of central administrative control over their actions in that respect will be found necessary, particularly if there seems to be any danger that the resulting certificates will be used to deceive or mislead the municipal public.

Both sanitary zeal and expedition in conducting public business are commendable qualities, but they alone would hardly seem to warrant the action of the City Council of Centralia, Wash., as portrayed in the following pen-and-ink sketch from the "Chronicle" of that city, which we reproduce verbatim:

> To-day the city is without a city health officer. The decapitation of Dr. David Livingstone happened all of a sudden last night at a meeting of the city council. The action of the council resulted from the alleged failure of the city health officer to attend to his duties, especially in the matter of compelling the connection of unsanitary places with the sewer. The councilmen took the position that the desired results might be better accomplished without the services of the city health officer, than with. A motion was made, seconded, put, voted upon and carried in about 1¼ minutes discontinuing the employment of the health officer. He has been receiving $25 per month from the city as health officer.

We pretend no knowledge of the merits of the case further than can be inferred from the low salary named and the reported conclusion to leave the office vacant.

It would be interesting to know how much work the city fathers of Centralia expected from their health officer in return for a salary of under $1 a day, or presumably less per day than he receives for a single visit to a patient. The apparent decision to get along without a health officer suggests that the council is of the opinion that there is not much work for a health officer to do anyway, and that the little needed calls for but little compensation.

Even a small place like Centralia could profitably utilize the full-time services of a competent sanitarian, not necessarily a doctor, and could well afford to pay such a man liberally.

## Conflicting Sanitary and Commercial Questions Raised by the Calumet District Sewage Disposal Problem, Chicago.

How far, in point of population provided for, sewage disposal by dilution can be carried by the Trustees of the Sanitary District of Chicago is becoming a more and more pressing question. Restricted by the State of Illinois, on the one hand, as regards the volume of diluting water which *must* be drawn from the lake for each 100,000 of population tributary to the Drainage Canal and, on the other hand, limited by the U. S. War Department as to the amount of water that *may* be diverted from the Great Lakes to the Mississippi drainage system, it is obvious that the natural increase in the population of the original area served by the canal would eventually call for a change of plan in the course of a few decades at most. Enlargements of the area served have suddenly brought the Trustees face to face with the alternative of securing more diluting water or adopting some means of purification for the sewage from the Calumet District, a large area recently annexed. Elsewhere in this issue we publish reports on the Calumet problem, all supporting the conclusion reached by the Trustees in 1904 to the effect that the sewage which now reaches and pollutes Lake Michigan by the way of the Calumet River can best be disposed of by means of a canal connecting the river with the main drainage canal. Such a canal would reverse the flow of the Calumet River, and would require the diversion of a considerable volume of water from the lake. This diversion, or additional diversion, the Secretary of War has refused to grant. The details of the subject, with references to previous reports which have been printed in our columns, may be found in the article already mentioned.

The Trustees appear to have decided to continue their program for the Calumet Canal, without waiting for the decision in the suit now pending in the U. S. Courts to determine whether the Secretary of War has the right to prohibit the further diversion of water from Lake Michigan. The assumption on which this proposed action is based seems to be that if the court decision is adverse to the Trustees they will appeal to Congress for specific authorization to divert more water from the lakes.

The primary question at issue is: which has the more just claim upon the waters of Lake Michigan and the other Great Lakes, the Sanitary District of Chicago or the other users of the lakes? The question is more serious and at the same time less simple than might appear to anyone not familiar with the situation. It involves, on the one hand, the present and future purity of the water-supply of Chicago and the adjacent and rapidly-growing district to the South and East in both Illinois and Indiana. On the other hand it involves a consideration of the use of the waters of the lakes for water power and navigation, including also the very complex problem of fluctuating lake levels.

It is universally agreed that public water-supplies take precedence over navigation and all other interests. It is particularly significant in this connection that this very principle is distinctly recognized in the "Waterways Treaty" between Great Britain (for Canada) and the United States, abstracted in our issue of June 9. Contrary to early reports this treaty contains no limitations on the amount of water which may be diverted to the Drainage Canal. Although the treaty states that it is expedient that the level of Lake Erie be maintained, and limits the diversion for power purposes at Niagara Falls, yet it specifically says that prohibitions as to diversion shall not apply to water taken for sanitary or domestic purposes or for navigation canals.

From a sanitary viewpoint the Drainage Canal serves the double function of protecting the water-supply and disposing of the sewage of millions of people—present and prospective.

Since the canal was put in use the typhoid death rate of Chicago has fallen to a figure that few American cities can show. But the increasing population in the Calumet District already threatens a considerable portion of the water-supply of the city and promises to be a far greater menace soon. The complete diversion of the sewage of this district from the lake would, of course, remove present danger of infection of the water-supply. Without a more or less complete diversion safety would demand the purification of either the sewage or the water, with the probability that both would have to be purified within a few years.

If a reasonable degree of safety could be ensured by sewage purification or by water purification, or by both combined, then obviously the conflict between sanitation and other demands upon the waters of the Great Lakes would fall into the realm of public economics, and the extra cost of purification over diversion would have to be compared with the damages to navigation, etc., caused by diversion, if it can be proved that there would be any material damages. The primary question of sanitary against other interests therefore resolves itself into various subsidiary questions, but though subsidiary yet involving such large and complex matters as the present status of sewage purification, in relation to the pollution of public water-supplies; the possibilities of water purification as a safeguard against gross sewage pollution, and the value of the water of the lakes for all other purposes than water-supply and sewage disposal.

It is useless to discuss the lake-levels question here, in view of the fact that a vast mass of data on that subject, presumably including new records, is being presented to the courts in the diversion suit between the U. S. Government and the Drainage District. The sanitary questions involved, although subject to possible radical change through advances in both water and sewage purification, may be discussed with more profit, particularly as the known facts and principles involved are far less local and special in character than those pertaining to lake levels.

Strictly speaking, the Trustees of the Sanitary District of Chicago have no concern with water-purification possibilities. With them, it is simply a question of sewage diversion against sewage purification, with the knowledge that if they for any reason, bad or good, fail to protect the water-supply then the burden must be taken up by others. But while this is true the Drainage Trustees may very properly consider what might be done in the way of water purification; for the taxpayers, who ultimately foot the bill, and the water consumers, who enjoy health or suffer sickness and death as a result of possible differences in the character of the water-supply, care far more about the results achieved than what public authority achieves them. Let us, then, glance briefly at both sewage and water purification chances.

Taking up sewage purification first, we might as well put the matter bluntly at the start. There is no system of sewage purification now in practical use, much less a system applicable to Chicago conditions, which can be relied upon to turn sewage into drinking water. A large average bacterial reduction might be effected if expense was not spared, but any system likely to be adopted would discharge large volumes of bacteria at unforeseen and probably frequent intervals. It should be noted, however, that the chances of infection of the lake would probably be reduced in greater proportion than the reduction in bacterial contents, owing to the greater percentage of removal of solid matters than of bacteria from the sewage. The solid matters removed would otherwise be deposited largely in the river, from there to be washed out, in part, towards the water-works intakes in times of flood. The pathogenic bacteria would probably decline in greater proportion than the others during the process of purification and during the period of detention in the river mud. Altogether, then, the reduction in infectious qualities might total quite a high average percentage, but there would be no certainty of uniform results. In other words, the lake would be subject to heavy doses of possibly infectious matter at more or less frequent intervals, first, due to heavy variations in the bacterial reduction effected by the purification works and, second, on account of sewage-sludge deposits washed out of the river bed at times of high water.

As to the possibilities of water purification little need be said. It is well known that a highly polluted supply can now be rendered reasonably safe by well-established methods of purification, but the expense is considerable. What the local obstacles might be in connection with the portion of the water-supply endangered by the present and prospective sewage of the Calumet section we do not know. So far as we have heard no one has ever given more than a passing thought to the possible need of water purification at Chicago, so no data on the subject appear to be available.

Thus far we have not considered the possible use of calcium hypochlorite or bleaching powder for treating either the sewage or the water. For sewage that agent has hardly passed the experimental stage. It has promise for disinfecting a sewage already highly purified by other and expensive means, but what the total cost and efficiency would be when dealing with a large volume of Chicago sewage cannot be predicted except on the basis of laboratory and other small-scale experiments. If hypochlorite were to be used in connection with the Calumet problem it would seem to promise better results at far less expense if applied to the water rather than to the sewage.

It should be understood that the sewage of the Calumet District presents a serious problem, quite aside from its danger to a portion of the water-supply of Chicago. It must be diverted from the river, in any event, as we understand it, or the Calumet River will eventually become as odorous and unsightly as was the Chicago

River before the Drainage Canal was put into use.

We have concentrated attention upon the relation of the sewage to the water-supply, because that aspect of the problem has been emphasized in the recent discussion and because it represents the subject in its most serious form. Furthermore, as we have already intimated, if dangers to the water-supply are not considered the problem becomes chiefly one of the comparative cost to the Drainage District on the one hand and of capitalized damages to navigation and commerce on the other, cost aside, there is no question as to the possibility of so treating the sewage that it can be discharged into the lake without offense to sight or smell.

We have said nothing as yet about one phase of the subject which may seem very important to some. We refer to the effect of discharging still more sewage southward into the Des Plaines, Illinois and Mississippi rivers. Obviously this is a matter relating chiefly or wholly to the use of those streams for water-supply purposes, for in the canal itself the sewage is diluted to an approved limit to prevent putrefaction, and is subjected to additional dilution in every mile of its course towards the gulf. We think it is generally conceded, that St. Louis, in its famous suit, was unable to make much of a case against the danger of this sewage to its water-supply, and since subsequent to that suit neither St. Louis nor any other city or person seems to have raised a voice on behalf of the water-supplies below the mouth of the Drainage Canal it seems hardly necessary to discuss the subject. It will be understood that in this paragraph we are assuming that sufficient dilution to prevent putrefaction will be continued in the future, or else that the putrefactive matter will be reduced by treatment before the sewage is turned into the Drainage Canal.

The outcome of this latest move on the part of the Trustees of the Sanitary District of Chicago is a matter of unusual interest. If the District is finally held to the diversion of 10,000 cu. ft. per sec. from Lake Michigan it will not only be compelled to purify the Calumet District sewage but it will ultimately also be forced to purify the sewage of a city which by that time may have a population of 4,000,000 or 5,000,000. The alternative would very likely be the purification of the water for a like population.

# LETTERS TO THE EDITOR.

## In Defense of a Criticized Floorbeam Connection.

Sir: I note in your issue of May 19 that "Girder Bridge" invites discussion of the merits of a standard floorbeam connection for shallow-floor railroad bridges. While you do not, as a rule, give any space to such small details of construction, they are doubtless interesting to many of your readers, and if "the man higher up" realized how much such small matters of manufacture and erection really affect the character of a design, he would not consider them beneath his notice.

Referring to the sketch submitted by "Girder Bridge," it is evident that the object of the special detail is to reduce the depth of floor to a minimum. This is accomplished in this construction, with the following advantages:

(1) No interference with stagger of rivets in either leg of flange angle of girder; therefore minimum reduction of flange area.

(2) Beams can be more easily swung into place between girders than if the ends were square.

(3) No countersinking of rivet heads to facilitate erection and no fillers required. This is important on account of close spacing of beams in shallow floors.

(4) No group of rivets doing double duty, for a separate group takes the shear from the floorbeam and the difference of flange stress in the girder. Thus if the floorbeam connection works loose from the pounding of passing wheels, the girders remain intact.

If "Girder Bridge" will work up a "simpler" design with equal advantages, bridge engineers will be glad to adopt it.

C. Derrick.

Culebra, C. Z., June 1, 1910.

## Waterproofing Wooden Bridges; Double Floor Planking Required.

Sir: We have just noticed the editorial in your issue of May 5 on the subject of waterproofing wooden bridges, and we think the article a timely one. However, there seems to be one point that was not brought out, viz., that as bridges are built the stringers run lengthwise of the bridge and the planking crosswise, and it is only in rare cases that more than one layer of planking is used. The result is that when heavy loads cross the bridge there is a slight deflection of the plank directly under the wheels, or we might say a wave or rather ripple effect back and forth across the bridge as each heavily loaded team crosses. The deflection of even a small fraction of an inch in the plank on which the load rests, with the planks next to it joining on each side remaining in their usual position will if continued break any felt-and-pitch waterproofing, no matter whether of two plies or five, that is confined closely between the plank and the material above.

It seems to us that an easy way of overcoming this weakness is to have two courses of plank, one laid at right angles or diagonally with the other, as the planks in the top course securely nailed to the under-course cannot bend independently of each other or those underneath, and while under heavy load there may be some slight deflection in the roadway, it will be so evenly distributed that the felt-and-pitch waterproofing course will not be damaged.

M. H. Phillips.
Barrett Manufacturing Co.

17 Battery Pl., New York City, June 9, 1910.

## Origin of the Low Ventilated Type of Trainshed.

Sir: I have just noted in your issue of May 12 that in making mention of the recent patent received by Mr. A. L. Moorshead for a direct ventilating trainshed you designate the trainshed as of the "Bush Type."

This type of shed was first suggested to two of Mr. Bush's assistants on the Delaware, Lackawanna & Western R. R., Messrs. E. I. Cantine and A. J. Philips, by Mr. Wm. H. Simms at a time when Mr. Bush was awaiting bids on an inverted umbrella type of platform roof for the Hoboken terminal of the Lackawanna, and when these assistants went to see Mr. Simms, then Station Master of Broad St. Station, Philadelphia, on an entirely different matter. The circumstance is proven by both the published statement of Mr. Simms and the recall of invitations to bidders on the umbrella type of construction.

The Moorshead design incorporates certain features which Mr. Simms was particularly careful to indicate to Messrs. Cantine and Philips, but I am unable to state whether the Moorshead patent is based on an independent invention or the use of these ideas which Mr. Bush failed to incorporate in his patent. However, both roofs are designed so distinctly on the lines indicated by Mr. Simms that the low direct ventilating trainshed should be named in honor of Mr. Simms (now Vice-President and General Superintendent of the Philadelphia & Western Railroad, Upper Darby, Pa.) for his unselfish efforts to obviate the stifling and dangerous conditions prevailing in the old types of trainsheds.

John I. Riegel.

Erie, Pa., June 9, 1910.

## The Prospects for Engineering Work Under the Government.

Sir: It is widely believed that Secretary Ballinger is hostile to the Reclamation Service, and it has been shown before a Congressional investigating committee that he is opposed to the men at its head, and that his attitude has already caused a partial demoralization of the Service. No doubt he would, before now, have made radical changes in the Reclamation Service had he not "had his hands up" (his own statement) during the greater part of the time he has been in office.

According to newspaper reports, a bill is now before Congress which authorizes the President to place an officer of the Corps of Engineers of the army in charge of any public work, and it is stated that this bill is favored by the Administration and likely to be passed.

It is also reported that it is proposed to appoint the present Chief of Engineers Director of the Reclamation Service when the bill becomes law. It is difficult to understand how the discharge of Director Newell and the appointment in his place of an army officer would benefit the Reclamation Service; but if it be done the President and Mr. Ballinger will certainly have succeeded in humiliating the civil engineering profession.

That the President should support his Secretary of the Interior, as long as he deems him worthy of confidence and qualified for his high office, is natural, and it cannot be denied that the President, while Secretary of War under the former administration, had some disappointing experiences with civil engineers in public service; but the Reclamation Service has done excellent work and has proved conclusively that public work, on a large scale, can be carried on by civil engineers, under sympathetic administrations, in a most efficient and economical manner, and without the slightest taint of graft or undue administrative difficulties.

The President is too broad-minded a man to be actuated by resentment aroused by former annoyances of civil engineers and it is reasonable to infer that if he consents to so radical a change in the organization of the Reclamation Service as above outlined he must have been wrongly advised by those of his cabinet whom he naturally would consult in the matter.

Instead of needlessly discrediting civil engineers and especially those at the head of the Reclamation Service, it would seem more reasonable to use that organization as a model for the creation of a national bureau or department of public works to take charge of all public civil engineering work, which could properly be brought under its jurisdiction, including river and harbor improvements. This need not, of course, exclude the army engineers, who could readily be made eligible to positions under such a bureau or department, and thus a means be provided for maintaining an engineer corps of the army much larger than is required for military engineering purposes in times of peace as long as this is thought desirable.

Officers of the Corps of Engineers, and others, have repeatedly told us of the baneful influence of the "political engineer" and corrupt politics in engineering, likely to be experienced when public works are executed under civilian officials, and the consequent great advantage of having army officers put in charge of public engineering enterprises, all of which has been realized by no class of men more fully than by civil engineers. Therefore, in the past, it has seemed that the gross unfairness and injustice, often suffered by civilian engineers under the War Department, must be borne uncomplainingly; but, thanks to the splendid record of the Reclamation Service, we now know that it is perfectly practicable to build up a large civil engineering organization under the government that in efficiency and honesty stands second to none anywhere.

Whatever the Administration may choose to do with the Reclamation Service, its record is secure and highly creditable and it has earned the lasting gratitude of the civil engineering profession. Unfortunately in the bitterness of the strife now raging about the incumbent of the Interior Department, the interests of the people most vitally concerned, the settlers on the reclamation projects, are in grave danger of being ignored.

Yours truly,
Peter Mogensen, M. Am. Soc. C. E.

Spokane, Wash., June 6, 1910.

## Notes and Queries.

"Student," who sent us an inquiry concerning arches, forgot to write his name on the letter. He is requested to reveal his identity, as we cannot publish anonymous communications.

THE CLEARANCE AT SWITCHSTANDS, or the distance at which the switchstand is set from the track rail, is a matter which has come up for discussion recently in Canada, in connection with the safety of men riding on the sides of cars in switching work, etc. The Board of Railway Commissioners of Canada also proposed to adopt the same standard clearance (6 ft.) for switchstands as for all other structures, but on account of the expense of making the change the plan was abandoned. Enquiries which we have made show the following as the practice of five railways. Numbers (1) and (5) give the distance from center of track to center of staff or mast; the others give the distance from the rail. No. (2) gives 6 ft. for high switchstands and 4 ft. for low switchstands. No. (3) states that there is no absolute standard for side tracks; a 3½-ft. connecting rod is used, which brings the staff about 4½ ft. from the rail, the actual distance varying with the pattern of the switchstand and the way in which it is set. No. (4) makes no difference between main track and yard switchstands, unless the location of the tracks makes this necessary; where the two switchstands come in the same line of sight, the post or the connecting rod of one is lengthened so that its target will show above or at the side of that of the other switchstand. The distance in this case is from the gage side of the rail head:

| | Distance from Rail to Post of Switchstand | |
|---|---|---|
| | Main-track switches, ft. ins. | Siding and yard switches, ft. ins. |
| (1) Chicago & E. Ill.* | 9 6 | 6 6 |
| (2) Chi., Mal. & St. Paul | 6 0 | 4 0 |
| (3) Cincinnati So. | 6 6 | 4 6 |
| (4) Grand Trunk | 5 4 | 5 4 |
| (5) Ill. Central* | 9 3/12 | 6 3/12 |

*Nos (1) and (5) give the distance from center of track.

## Concrete and Tile Floors with Two-Way Reinforcement.

One of the best known and earliest fire-proof floor constructions is that in which the span between either reinforced-concrete or protected steel floor-beams is made by hollow clay tile spaced some inches apart with the intervening spaces filled with concrete reinforced with longitudinal rods and with a concrete floor slab laid

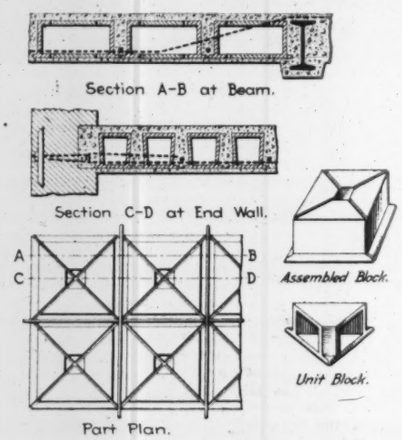



Fig. 1. Details of the Burchartz Two-Way Reinforced Concrete and Tile Floor System.

over the whole plane thus made. This type of construction has now been used as a basis for a new type in which advantage is taken of the excess strength gained by two-way reinforcement. That is, instead of the intervening concrete-filled spaces between the tile running only in one direction (in line with the shorter span) the spaces are made in the direction of both lines of supporting floor beams, and the whole construction, when the concrete slab has been placed, takes the form of a crossed system of T-beams filled in between with hollow clay tile.

Two systems of this general type have recently come to our notice, one an American patent, which has been employed to some extent in this country, notably in schoolhouses in Newark, N. J., and one of French design, which, so far as we know, has not been used in the United States.

### The Burchartz System.

The American system is one designed by Mr. Ferdinand Burchartz, and controlled by The Building Improvement Co., of New York City. Its main item of novelty is in the design of the tiles, which are shown in Fig. 1. Each unit of these tiles is made up of four equal parts, which, when joined together make a hat-shaped hollow prismatic block with a projecting bottom flange that leaves a space of about 3 ins. between adjoining units. These blocks are laid on flat forms between floor-beams spaced equally in both directions and in the longitudinal and transverse openings are placed reinforcing bars designed to take the strains in the T-beams so formed. Concrete is then poured into the openings, and over the entire surface, in the same manner as is done for the old type one-way tile and concrete floors. The bottom of the tile are roughened so that a plaster ceiling can be directly applied thereto.

In the design of this floor it is assumed that the beams in each direction, if continuous, have a bending moment of $\frac{Wl}{12}$ and each direction can take one-half of the load. When the opening is not square, the shorter beam is assumed to take the larger proportion of the unit load $W$ according to the following ratio:

$\frac{L}{R}$ = ratio of length of slab to breadth.

$K$ = proportion of unit load taken by shorter beam.

| $\frac{L}{R}$ | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| K | 0.50 | .59 | .68 | .74 | .80 | .84 | .87 | .89 | .91 | .93 | .94 |

On one of the school buildings in Newark where spans averaging 20 × 20 ft. were used, with a live load varying from 70 to 200 lbs. per sq. ft. and averaging 120 lbs. per sq. ft., the loads per sq. ft. of the floor were as follows:

| | |
|---|---|
| Concrete, 1:2:4 | 9.0 |
| 0.6 terra cotta block at 12 cts. apiece | 7.2 |
| 2 lbs. steel rods, at $0.0225, in place | 4.5 |
| Centering | 4.5 |
| Laying blocks | 0.4 |
| Costs per sq. ft. | 25.6 |

It is claimed by the company that through the lightness of the system and the large spans possible, the cost of the steelwork on this building was reduced 30% over that designed for terra cotta arches. If this estimate is correct the saving per sq. ft. of floor on steel would amount to 16 cts. making the cost of the floor, including general expenses of construction and the royalties on the system, about 9.6 cts. per sq. ft. In this estimate, sand was $1.60 per cu. yd., broken stone $2.25 per cu. yd., cement $1.17 per bbl., and laborers and mechanics from $3.50 per day for concrete men to $4.00 per day for carpenters. It will be noted that the cost of centering is very low on account of the low quality of planking required and the simplicity of the framing.

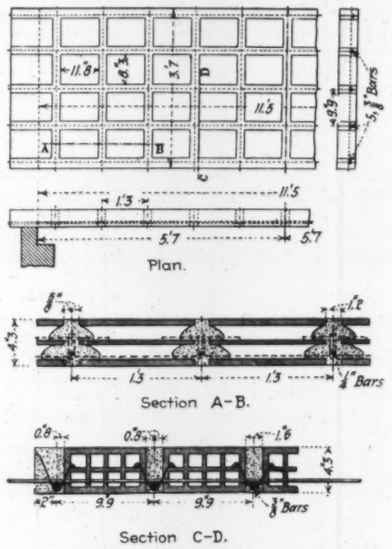



Fig. 3. Detail of a Slab of the Aragon System of Two-Way Reinforced Concrete and Tile Floor.

In another school building in Newark, the floor plan is about 90 × 30 ft. in area and is divided by concrete-encased steel I-beams across the 30-ft. spans into three bays each approximately 30 × 30 ft. in plan. These bays are crossed by the Burchartz system, with 7-in. blocks and a 2½-in. cover of concrete, making the total depth of the concrete at the T-beam 9½ ins. The reinforcement consists of crossed ⅞-in. corrugated bars, one to each T-beam. After this floor had been in place 10 days, the falsework was removed from under one of the bays, at a time when there was in its middle a concentrated load of 6,000 lbs., and after 10 hours it was found that the permanent deflection was ¼-in.

The Burchartz standard blocks are made in heights varying by inches from 4 to 8 ins. and in weight per sq. ft. from 18 to 32 lbs. All blocks are 15 × 15 ins. on the bottom and 12 × 12 ins. on top. The 8-in. blocks have a horizontal middle web but all the smaller blocks are hollow, as shown in Fig. 1. The company is prepared to build the floor for clear spans up to 40 × 40 ft. in area. For this large span the following data are given:

| Live load, lbs. | Dead load, lbs. | Total thickness floor, ins. | Hgt. of terra cotta block, ins. |
|---|---|---|---|
| 150 | 90 | 15 | 10 |
| 120 | 81 | 13½ | 10 |
| 80 | 72 | 12 | 9 |
| 60 | 63 | 10½ | 8 |

Mr. John C. Sample is consulting engineer for the company.

### Aragon System.

"Le Genie Civil," Dec. 4, 1909, illustrates a somewhat similar type of floor known as the Aragon system. The main point of difference between this and the Burchartz type is that the tile in the former are the ordinary hollow terra-cotta block with openings running through in one direction. This leaves an opening into which the concrete from one line of beams can run into the tile. The inventor claims that this gives a very desirable bond, and that the additional weight is not of any great importance. It should be noted that the concrete can not be of the sloppy kind generally used in reinforced-concrete

FIG. 2. VIEW OF BURCHARTZ FLOOR TILE IN PLACE.

work but that it must be so stiff that it will not run very far into the opening.

Fig. 2 illustrates a typical floor of the Aragon type where the slab opening is not square. In this case the reinforcement is heavier in one direction than the other on account of this difference in beam lengths, but the method of reinforcing is well shown. It will be noted that the ratio of length to breadth is 3.2, which is much greater than is allowed for the Burchartz type. Indeed, with so great a ratio it seems that the utility of this double way system is doubtful, mainly because theoretically the heavy rods should be in the short spans instead of the long as shown, but that does not detract from the value of the Aragon type if more nearly equal spans are used. One point of novelty in this type is the chair in which the heavier rods are held.

The floor shown in Fig. 2 was tested to destruction supported only on the short ends, with the following results:

The slab is designed for the very light loading of 192 kg. per sq. m. (39.3 lbs. per sq. ft.) and has no top slab of concrete, so that its entire strength is in the concrete beams. It is 11.5 × 3.6 ft. in area and 4 $^{9}/_{16}$ ins. deep. The terra-cotta blocks are 4 $^{9}/_{16}$ × 8¼ × 11¾ ins. The long way reinforcing is of five $^{7}/_{16}$-in. deformed bars and that in the short beams is of single ¼-in. rounds. A 1:1 sand-cement mortar was used. The test was made only 12 days after the slab had been poured, and during most of that time was subjected to heavy rains. For a uniform load over the entire slab of 39.3 lbs. per sq. ft. (the designed load) the maximum deflection in the center of the slab was ⅛-in.; for a load of 79 lbs. per sq. ft., ¼-in., and rupture took place by failure in tension of the main rods near the center at a load of 163 lbs. per sq. ft.

# Economy of Modern Reversing Rolling-Mill Steam Engines: New Single-Lever Control with Regulation by Cut-Off.*

By EDUARD G. SEHMER,† and DR. R. DRAWE.†

The remarkable economy in fuel achieved by the use of the gas engine led to endeavors to adopt it as the sole source of power in ironworks, and where its direct application was impracticable it was attempted to drive by electricity, generated by gas-engine power. In attempting to take advantage of the lowest possible fuel consumption, the consideration of total efficiency, taking account of all other factors involved, was lost sight of. These factors, however, are largely influenced by local conditions and play an important part.

A typical instance of this nature is the driving of rolling mills. Until the time when the problem of generating electricity by means of gas engines was successfully solved, it was the universal practice to drive reversing rolling mills with reversing steam engines which, in their original form, were great steam-eaters. Shortly before the idea of driving rolling mills electrically took practical shape, however, the lines upon which economy in steam consumption could be improved had become generally recognized, but, as economically working engines were comparatively rare, the comparative calculations of performances of steam versus electric driving apparatus were usually based, in the case of steam driving, upon engines of the most uneconomical type. Hence it was claimed that the superior economy of the electric driving was proved. Now that a large number of economical reversing steam engines is installed a totally different aspect is presented which it is proposed to discuss in this paper.

## Requirements of a Rolling-Mill Engine.

In the first place it is necessary to set forth the requirements which a good rolling-mill steam engine should possess, and to consider the means by which these requirements can be practically fulfilled.

Ease of manipulation, reliability, and efficient utilization of the steam are the special points by which the total efficiency of a reversing rolling-mill engine may be judged. In particular, the engine must fulfill the following conditions:

1. The engine must be capable of starting easily in any position, and must grip the material to be rolled at a regular and moderate speed.

2. When running slow, that is, at starting and stopping, the engine must not stick under an increasing load, or race as the load falls off.

3. In rolling down, that is, during the period of greatest energy consumption, the engine must work as economically as possible, with a minimum steam consumption.

4. When the billet has left the rolls, the engine must be quickly brought to rest.

The primary consideration is that the engine must be capable of such rapid control that the mill shall never have to wait for the engine.

## Compound Engines.

Experience, meanwhile, has shown that the requirement as to minimum consumption of steam can only be fulfilled by compounding. The advantages of compounding consist in the ability to carry the degree of expansion further, in decreasing the amount of temperature drop in the cylinders, in the reduction of steam loss due to leakages, and in obtaining a more perfect condensation.

The first compound, reversing, rolling-mill engines only partially fulfilled these desired attainments; and the advantages which it was hoped to achieve by compounding were neutralized through loss of ease in manipulation, and more especially through the excessive number of idle revolutions. With these engines, as soon as the ingot left the rolls, the steam below the throttle-valve of the high-pressure cylinder continued to work, as did also the steam still stored in the receiver between the high and low pressure cylinders, and the engine came to rest only when the whole of the steam in the cylinders was exhausted. This resulted in the waste of both steam and time, owing to so much idle running. Excessive cooling losses also occurred, particularly with condensing engines, and sometimes even vacuum was noticeable in the high-pressure cylinder. The advantages of compound working were, therefore, largely if not entirely discounted. Moreover, at starting, that is, when the maximum power effect is required at the moment of gripping the ingot, the high-pressure cylinders alone did the work, which necessitated the use of very large cylinders in order to meet the requirements of the mill.

Cockerill's were the first, in 1882, to remedy this defect, by placing a stop-valve in front of the low-pressure cylinders. This stop-valve, or cushion-valve as it is called, is operated simultaneously with the high-pressure throttle-valve. When the engine is stopped the steam from the receiver to the low-pressure cylinder is shut off, so that what is stored in front of the cushion-valve cannot continue to work in the low-pressure cylinder, and idle running is thereby almost entirely obviated. Further, as the steam thus retained in the receiver acts as a brake to the high-pressure cylinder, a compound engine fitted with a cushion-valve is more quickly brought to rest than the old type of high-pressure engine; that is to say, the rolling mill can be worked more quickly. In starting the engine, especially at the moment of maximum load, the steam stored up in the receiver enables the low-pressure cylinder to work immediately at full power along with the high-pressure. This arrangement was subsequently most successfully developed by the firm of Sack & Kiesselbach, and the steam consumption of their reversing engines was very considerably lowered thereby.

METHOD OF OPERATION WITH CONTROL BY THROTTLING.—The method of operation of such engines is as follows: The driver throws the link full over with the reversing lever, then with the starting lever he partially opens the throttle-valve in front of the high-pressure cylinder and the cushion-valve in front of the low-pressure cylinder. The engine then starts with throttled steam and late cut-off. As soon as the rolls have gripped the ingot, the throttle-valve is opened out farther, and the working of the machine is controlled by more or less wire-drawing the steam. The engine is stopped by shutting both throttle-valve and cushion-valve together. The driver then throws the link back to the opposite position, and repeats the operation as before.

Though this practice assures rapidity of handling, it by no means enables the condition of minimum steam consumption to be complied with. It is absolutely essential, at starting, to obtain diagrams with late cut off and heavy wire-drawing of the steam that the engine may start in any position and maintain an even speed of running. Once the ingot is gripped and the engine is speeded up—that is, during regular rolling—then it is absolutely required, as the condition of minimum steam consumption, that the engine be adapted to the power requirements of the rolling mill by adjustment of the cut-off. Only on stopping again should the diagrams show late cut-off and a corresponding degree of wire-drawing. This, of course, as it is almost unnecessary to mention, is the mode of working locomotives in general practice.

With control, by means of two levers and with cushion-valves, the driver can, at discretion, open the throttle-valve full, as soon as the ingot is fairly gripped, and regulate the engine by means of linking up. This is, however, rather a troublesome business, and, moreover, requires a good deal of intelligence on the part of the man. It has, further, been endeavored by means of suitable devices to oblige the driver, during rolling, to economize consumption of steam, by linking up and opening out the throttle-valve, but all efforts in this direction to obtain regular control have proved fruitless.

## Regulation by Cut-Off with New Single-Lever Control.

Experience has shown, in fact, that the only solution of the problem is to remove it out of the power of the driver to adjust the distribution of the steam according to his own judgment, and the only means of carrying this into effect is to employ a properly designed single-lever control. For rapid manipulation, the conditions of such a starting gear require that, at starting and stopping, the diagrams, without intervention on the part of the driver, should show a late cut-off with throttled steam and during rolling—that is, while running quick—they should show an earlier cut-off in both the high-pressure and low-pressure cylinders. Further, the starting gear must be so contrived that, on stopping the engine, the steam to the low-pressure cylinders is shut off by an effective and simple arrangement so as to bring about a cushioning effect.

Another essential feature of the scheme is a reliable and quickly working reversing apparatus. The single-lever gear has throttle-valves in front of the high-pressure cylinders only. In order that the driver may not have it in his power to regulate the speed with these valves and thus waste steam, they are connected to, and controlled by, the mechanism for shifting the link. When the engine is stopped the link is in mid-position and the throttle-valves are closed. When the link is thrown over to start the engine, the throttle-valves are immediately opened automatically, and so quickly that no wire-drawing takes place, even when the engine is running at full speed. Thus all conditions as regards the actual rolling are fulfilled, but not those for starting and stopping—namely, diagrams showing wire-drawing with late cut-off.

AUXILIARY PORTS.—The new single lever gear provides for this in the following manner: The slide-valve faces are provided with auxiliary ports which, when the engine is linked up to a certain amount—that is, when the main slide valve is cutting off steam at 20 to 30% of the piston stoke—will admit auxiliary steam for a distance of 40 to 55% of the stroke, which is sufficient to start the engine. The closer up the gear is linked the later is the cut-off of the auxiliary steam which, however, is only used for starting and stopping, and is automatically shut off during the actual work of rolling. Further, the auxiliary ports are so determined that they reduce the excessive cushioning when the main gear is linked up to give an early cut-off. The construction has also the advantage that it does not involve any increase in the weight in the moving parts. As the auxiliary valve ports are intended to admit only wire-drawn steam they are made very small in proportion to the main steam ports, their area being only about one-tenth to one-twelfth that of the latter.

The single lever gear has also to fulfill the condition that, in stopping, the admission of steam from the receiver to the low-pressure cylinder is shut off, an operation which can be effected in the simplest way imaginable. The dimensions of the low-pressure admission are such that, so long as the link is in mid position, the steam passage to the low-pressure cylinder remains closed.

METHOD OF OPERATION.—The working of the whole arrangement is as follows: When the engine is stopped the lever, that is, the slide block, is in the center. The throttle-valves in front of the high-pressure cylinders are closed, as is also the admission to the low-pressure cylinder. When the driver moves the lever slightly in either direction, the throttle-valves open automatically, and the main slide-valves admit steam for about 20% of the piston stroke, which is not sufficient, however, in most cases to set the engine in motion. At the same time, the auxiliary ports admit steam for about 40 to 50% of the stroke, thus giving the engine the necessary turning moment to enable it to start, without allowing it, however, to run away if unloaded, since the steam is strongly wire-drawn in consequence of the small area of the auxiliary ports.

As soon as the rolls grip the ingot and the driver wants to speed up, he moves the lever further over, increasing the admission through the main slide-valve. At the same time the auxiliary ports are automatically shut, and the driver can now only regulate the speed by adjusting the cut-off, as the throttle-valves, the movement of which is governed by the mechanism of the starting gear, are already wide open.

Towards the end of the pass, the driver can again bring back the starting lever without risk of the engine sticking, for the auxiliary ports again open and give diagrams with wire-drawn steam and late cut-off, which automatically increases if the speed becomes too slow, thus giving the necessary turning moment for finishing the billet. Directly the ingot leaves the rolls, the driver puts the lever in the center, thereby closing the throttle-valves of the high-pressure cylinders and the admission to the low pressure, and the engine stops dead at once.

At a convenient point in the main steam pipe a quick acting stop-valve is placed, for the purpose of instantaneously shutting off steam independently of the starting gear, in case of danger.

*From a paper presented at the annual meeting of the Iron and Steel Institute in London, England, May, 1910.
†Saarbrücken, Germany.

RESULTS OBTAINED IN PRACTICE.—Nine engines fitted with this very simple gear are already installed, and eleven more are in course of construction. Diagrams taken from these show at a glance that the steam consumption is remarkably economical. More particularly they show (1) that the output of work of the engine is controlled by regulation of the cut-off; (2) that the proper amount of cushioning takes place, and (3) that the number of idle revolutions is very small.

A comparison of these diagrams with those published by Ablett* in 1909 is also very instructive. It will be noticed that these latter indicate regulating by throttling with late cut-off, and a very bad distribution of the steam. In comparing them with the author's new diagrams, the cause of the surprising economy in steam obtained with the new engine is quite apparent. A modern rolling-mill engine can, in fact, cope with the same amount of work on a consumption of about 35 to 50% of the quantity of steam formerly required.

### Superiority of the Steam Engine as a Prime Mover for Rolling Mills.

It is a comparatively difficult matter to obtain trustworthy results of tests of the steam consumption of a reversing rolling-mill engine, and it is therefore intelligible that up to the present no tests have been made on rolling-mill engines working under modern conditions, or, say, with a boiler pressure of 140 to 170 lbs., with high superheat and with a vacuum of about 24 ins. in the exhaust pipe. The tests so far made have all been performed at considerably lower steam pressure, low superheat, and low vacuum. They have yielded, nevertheless, extraordinarily favorable results.

Reference may be made to the 45-hour test on a rolling-mill compound engine recently carried out by the (German) Commission on the Power Requirements of Rolling-Mills. The mean pressure on the engine was 103 lbs., the mean temperature of the steam in the cylinders was 361° F., and the mean vacuum was 23.5 ins. The average steam consumption was 350.77 lbs. per ton of material rolled down to 9.222 times its original length. Under equal conditions, and with the same amount of elongation, the steam consumption was formerly 880 to 1,110 lbs. per ton.

The amount of steam consumed includes the whole of the feed water necessary for the engine, together with all the auxiliary engine and steam pumps for the condenser. As already indicated, the figures are comparatively high for the new type of engine, the conditions being not very favorable as regards either steam pressure, superheat, or vacuum. Besides which the engine was controlled by throttling, and not by adjustment of the admission and cut-off. In the case of a reversing-engine in conjunction with a modern steam-boiler battery, the steam consumption for a tenfold elongation would be about 308 lbs., as compared with 900 to 1,210 lbs. in the case of the uneconomical high-pressure engine.

With this low steam consumption,† the modern reversing compound engine holds the record for the lowest energy consumption per ton of material rolled. As it is also the cheapest rolling-mill engine, and unsurpassed by any engine in ease of manipulation, it holds the foremost place as compared with any other reversing apparatus for driving rolling-mills, especially the excessively costly motors for electric driving.

The high consumption of steam in the older types of rolling-mill engines has now led to the adoption of exhaust-steam turbines in conjunction with rolling-mill plant, but the advantages of exhaust steam turbine driving are, in most cases, greatly overrated. Some very instructive experiments have also been made in this direction by the above-mentioned Commission on Power Requirements of Rolling-Mills. The experiments were carried out at the "Union" works at Dortmund on engines whose exhaust steam was applied to driving rolling-mills. The result showed that the steam consumption of a compound rolling-mill engine, that is, a very economically working one, was increased by 35% by the interpolation of an exhaust-steam turbine between it and the central condenser.

The experiments led to the conclusion that no economical advantage results from the use of such a turbine, for the chief reason that the extra 35% of steam used in the reversing-engine would be sufficient to develop the same amount of energy in a live steam turbine as would be obtained by means of installing the rather complicated and costly exhaust-steam-turbine plant.

*"Journal" of the Iron and Steel Institute, 1909, No. II., p. 15.

†With steam costing 30 cts. per ton, the cost of the steam used per ton of material rolled to 9.22 of its original length, in the case of the engine described, would amount to 10 cts. When working under modern conditions, and rolling ingots to ten times the original length, the cost would not exceed 8.8 cts.

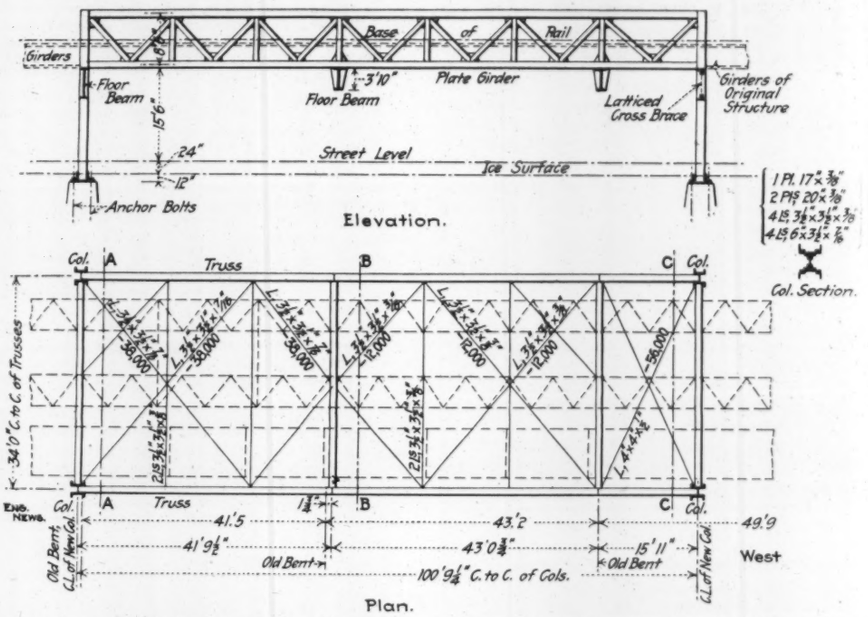



FIG. 1. PLAN AND ELEVATION OF 100-FT. TRUSS SPAN CARRYING THE METROPOLITAN ELEVATED RY. ACROSS A SKATING RINK AT PAULINA ST., CHICAGO.

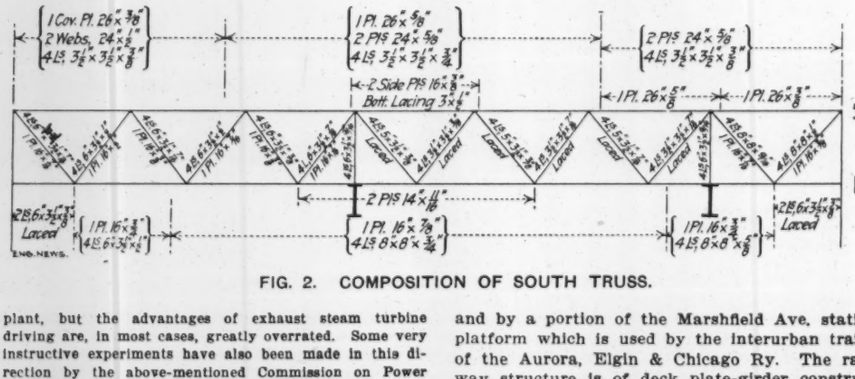
(The dotted lines show the old work now carried by the truss span instead of by intermediate columns.)

## Carrying an Elevated Railway Across a Skating Rink by a 100-ft. Truss Span.

The construction of a 100-ft. truss span to carry the girders of an elevated railway, and to enable the original intermediate supporting columns to be removed, is an interesting piece of work which has been completed recently in Chicago, and which, of course, had to be carried out without interference with the very heavy traffic on the railway.

The Ice Rink Co., of Chicago, has erected a building for a skating rink on the west side of Paulina St., between Van Buren and Congress Sts. The site is crossed by the Garfield Park line of the Metropolitan West Side Elevated Ry., and by a portion of the Marshfield Ave. station platform which is used by the interurban trains of the Aurora, Elgin & Chicago Ry. The railway structure is of deck plate-girder construction, having four lines of girders averaging 45 ft. span, the two girders of each track being supported on the Y-shaped or flaring top of a single column placed under the center line of the track. In addition, there are two lines of girders for the platform. The Ice Rink Co. desired a clear span of 100 ft. through its building, and this necessitated the removal of three rows of columns. Two other lines of the elevated railway cross the site (Marshfield Ave. being a junction), but these do not cross the rink floor and no alterations are required.

The plan adopted was to erect a pair of 100-ft. semi-through lattice trusses, one on each side of the railway and carrying transverse floor beams to support the existing plate-girder spans (which thus become the track stringers of the new structure) and the platform girders. The two columns at the east end are in line with the old columns, but spaced farther apart, while the columns at the west end are on the line of the rink company's property. The general design is shown clearly in Figs. 1 and 3, the dotted lines representing the original work left in place. The columns are built-up, of double-channel section, with central web. The trusses have top chords of trough section, while the bottom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chords and web members are of H-section, composed of four angles with a web plate or web lacing. Fig. 3 gives the composition of the south truss. The north truss is practically identical with it, but has somewhat lighter material in some of the members.

The live load for each track consists of 88,000-lb. motor cars with 22,000 lbs. on each axle, the truck centers being 33 ft. apart and the truck wheelbase being 6.5 ft.; the truck centers of adjacent cars are 12 ft. apart. The live load for the platform is 80 lbs. per sq. ft., and for the platform canopy it is 20 lbs. per sq. ft. The stresses are as follows: (1) tension, 10,000 lbs. per sq. in. net for main members and 18,000 lbs. for wind bracing; (2) shear, 6,000 lbs. per sq. in. gross. The weight of the material for the new parts of the structure is about 105 tons, as follows:

| | | Lbs. |
|---|---|---|
| 2 | Trusses (in 6 sections) | 117,410 |
| 3 | Cross girders | 46,310 |
| 1 | Cross bracing | 3,170 |
| 4 | Columns | 29,480 |
| 20 | Hangers | 7,240 |
| 20 | Laterals | 4,380 |
| 4 | Struts | 3,065 |
| | | 211,055 |

The method of construction was as follows. The new concrete pedestals or piers were put in on the west side, and the columns erected. Falsework was placed under the original structure on each side of the east columns. The original east columns were then removed, the old concrete piers upon which they rested were taken out, and the new concrete piers were

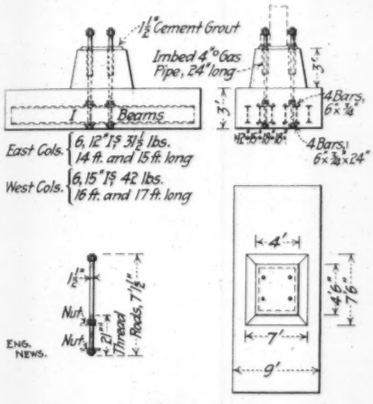


Fig. 4. Foundation for Columns.

built. The new east columns were then erected. The trusses were delivered in sections, and were assembled and riveted together on cribbing alongside of the old structure. They were then raised to place by jacking and cribbing, and connected to the columns. The east transverse girder was then erected in place, thereby permitting the removal of the falsework to the next row of old columns, which were taken out and replaced with the transverse girder or floor beam. The same process was followed at the last row of intermediate columns.

The pedestals for the columns are 3 ft. high, 4 × 7½ ft. at the base, and each rests on a 3-ft. slab 9 × 17 ft. or 9 × 15 ft., the greater length being transverse to the tracks. This base is reinforced by six 12-in. or 15-in. I-beams, 14 ft. to 16 ft. long, as shown in Fig. 4.

This work was done without any interference to traffic or to the station platform, or to the main body of the structure, except for the removal of the columns which were replaced by transverse girders supported from the new trusses. The work was erected by the Strobel Steel Construction Co., of Chicago, and Mr. R. N. Wade, Assistant Engineer, was in direct charge for the railway. For drawings and information we are indebted to Mr. B. J. O'Fallon, Assistant General Manager of the Metropolitan West Side Elevated Ry.

It is of interest to note that this is one of a number of cases in which the Chicago elevated railways have been altered to meet special conditions. In several cases they have been raised to allow the necessary clearance for track elevation on railways passing beneath them, in one case a through truss bridge was built to replace a number of short girder spans, and in another case extensive work has been done to provide additional tracks and to reduce curves. Much of this work has been described in our columns.

## Notes from Engineering Schools.

UNIVERSITY OF ILLINOIS. — Upon the recommendation of Mr. Robert Quayle, Superintendent of Motive Power and Machinery, Chicago & North Western Ry. Co., and with the approval of Mr. W. A. Gardner, General Manager, the locomotive testing plant of this railway has been presented to the University of Illinois. Under the immediate direction of Mr. H. T. Bentley, Assistant Superintendent of Motive Power and Machinery, it has been taken from its foundation, the bearings and other running parts have been put in good order, and the plant with all the special patterns used in its construction has been shipped to the University. It is understood that the plant will be held by the University pending the construction of its proposed transportation laboratory, and it is announced that the plant will constitute a portion of the equipment of the School of Railway Engineering and Administration, and that when installed it will be operated under the immediate direction of Prof. Edward C. Schmidt, in charge of Railway Engineering.

The plant consists of foundation plates, pedestals and three pairs of axles with their bearings, supporting wheels, friction brakes, etc. It was the first of its kind to be supplied with permanent mounting rails, by use of which a locomotive could be rolled on or off the wheels without resort to temporary blocking.

The plant was designed under the general direction of Mr. Quayle aided by Mr. E. M. Herr, now Vice-President and General Manager of the Westinghouse Electric & Manufacturing Co., but at that time Assistant Superintendent of Motive Power and Machinery. Mr. Quayle had been made chairman of the Master Mechanics' Committee on Exhaust Pipes and Steam Passages, and some time before while Master Mechanic at South Kaukauna, Wis., had improvised a testing plant by lengthening out the members of a passenger-car truck to make the wheel spacing agree with that of the drivers of the locomotive he desired to test, and by mounting this truck bottom side up in a pit in such manner that he could run a locomotive upon it. Encouraged by these earlier experiments he later advocated the testing of locomotives at the Fortieth St. shops of the railway company. The result was the plant which is now being sent to the University of Illinois. The proceedings of the Master Car Builders' Association show that the plant was an important factor in the development of several committee reports dealing with design of exhaust pipes, steam passages, draft pipes and stacks. The plant was also used in solving many problems of immediate interest to the Chicago & Northwestern Ry., but of late years it has been idle.

TWO INTERESTING DERAILMENTS were reported this week. Fast mail train No. 7 on the St. Louis, Iron Mountain & Southern Ry. was derailed June 9 near the city limits of St. Louis, Mo., and crashed through the wall of a building owned by the Miller Manufacturing Co. The engineer, fireman and a mail clerk were killed and two others were severely injured.

A freight train on the Canadian Pacific Ry. was derailed June 10 by the debris of a landslide on the main line near Port Coldwell, Ont. The train is reported to have plunged from the track into Lake Superior. Three trainmen were killed.

A HOISTING BUCKET SPILLED TEN MINERS into the 700-ft. shaft of the Richard iron mine, near Dover, N. J., June 7 and five of the men were killed. The other five escaped, some by clinging to the bucket and some by catching the rungs of the ladder in the shaft. The mine is owned by the Thomas Iron Co. The company's rules provide that only four men shall ride in the bucket at one time. With its overload of six extra men, some of whom were sitting on its rim and clinging to the bail, the bucket overturned when nearly at the top of the shaft.

A WATER TANK WRECKED A BUILDING at Montreal, Que., June 13. The supports of the tank used to supply the sprinkler system of the "Herald" building gave way and the tank, weighing, with the water it held, 150 tons, smashed its way down through the roof and all the five floors of the building to the basement. There were about 300 people in the building at the time, and 35 of these were killed. The victims were for the most part persons employed in the bindery and composing room, which occupied the rear portions of the upper floors. The front portions of all floors remained in position and many of the occupants of the building were rescued by ladders from front windows. Fire started in the ruins, from the furnaces of the stereotyping department, and made it impossible to rescue many of those who had fallen into the basement.

The building had a frontage of about 60 ft. It was an old structure, remodelled, and through the center from front to rear ran a heavy stone wall which had formerly divided it into two store buildings. The tank was mounted on steel girders extending from this central wall to one of the side walls. It was nearly over the center of the building but a little to the rear. The tank landed in the basement on the opposite side of the center wall from that where it had stood.

A FIRE AT SEATTLE, WASH., broke out on the night of June 10 during a high wind and destroyed all the buildings in six city blocks along the northern waterfront. Other buildings at a distance were ignited by brands carried by the wind. The fire was gotten under control only after the wind suddenly abated and rain began to fall. The district entirely burned out is bounded on the west by Railroad Ave.; on the east by Second Ave.; south by Battery St., and on the north by Vine St. Among the larger buildings destroyed was that of the Puget Sound Sheet Metal Works. The total loss is estimated at $1,000,000.

A WIND STORM AT PINE BLUFF, ARK., June 9, wrecked a number of the principal buildings, including a part of the telephone exchange, and put the city lighting plants out of commission. Several launches were sunk along the river front. Heavy damage to cotton and other crops is reported from adjacent agricultural regions. The storm lasted about one hour and was accompanied for a part of that time by a shower of hail.

A FLOOD IN GERMANY in the valley of the River Ahr, Rhenish Prussia, June 12, swept away many bridges and caused heavy damage in the villages along the river. At the village of Schult, 50 spectators of the flood lost their lives when the bridge on which they were standing collapsed. The total loss of life from the flood is placed at about 200. The railway along the valley was washed out and reports state that only one bridge across the river is left standing. The flood was the result of heavy rains which have been general all over Germany for several days. The river burst its banks after the especially heavy downpour on the evening of June 12.

Electrical storms in Germany, some note of which was published in our issue of June 9, have continued during the past week, bringing the total loss of life by lightning up to 45.

THE MILES GLACIER BRIDGE of the Copper River & Northwestern R. R., across the Copper River in Southwestern Alaska, was completed last month and on June 1 was opened to traffic. This bridge was built under exceptional difficulties, in particular because its piers required to be made capable of resisting the impact and pressure of icebergs. Concrete icebreakers upstream of the piers, faced and reinforced heavily with steel rails, assist in protecting the structure against ice attack.

THE BERGEN HILL CUT OF THE ERIE R. R. in Jersey City, N. J., a mile west of the railway's New Jersey terminal, was opened to traffic on June 13, after three years of construction work. This cut was described in Engineering News of Feb. 21, 1907, p. 204. It is about 5,100 ft. long and has a greatest depth of about 60 ft. Within the length are included four tunnel sections, respectively 190, 285, 235 and 580 ft. long; the remainder is open cut in firm rock. The whole improvement is four-track. The tunnel sections are lined with concrete and a large part of the open cut has retaining or parapet walls at the tops of the banks. The cut lies immediately alongside and partly above the double-track Bergen Hill tunnel which has hitherto carried all the traffic of the road. In future the tunnel will be used for freight only, while all passenger trains will go through the cut.

A long heavy four-track viaduct was required for the east approach to the cut, this being at a higher elevation than the tunnel portal. At the west end of the tunnel

extensive track relocation was made, to separate the five or six separate traffic lines which combine in the terminal, and to eliminate grade crossings. The whole enterprise, involving very costly and in parts very difficult work, is now practically completed. The cut is not yet in shape for four tracks, but the two center tracks are in place and will carry the passenger trains for the month or more needed to complete the work.

THE CANADIAN FOREST RESERVE in the Rocky Mountain region has recently been increased by an order in Council to a total area of about 14,400 sq. mi. Of the areas now reserved in the Canadian Rockies, Rocky Mountain Park contains 4,500 sq. mi., Jasper Forest Park, 5,000 sq. mi., and Waterton Lakes Park, 54 sq. mi. The new reserve just closed comprises about 4,850 sq. mi. The most northerly boundary of the reserve is situated between 40 and 50 miles north of the latitude of Edmonton and about 100 miles northwest of Yellowhead Pass; the western boundary is on the line between the Provinces of Alberta and British Columbia on the crest of the Rockies and the territory extends eastward down the eastern slope of the mountains. The southern boundary is the international line. The width of the strip set aside varies from 10 to 30 miles at the southern end to about 50 miles north of the latitude of Calgary.

AN AEROPLANE FLIGHT from New York to Philadelphia and return was made by Mr. Chas. K. Hamilton on June 13, for a prize of $10,000 offered jointly by the New York "Times" and the Philadelphia "Public Ledger." The trip was marked by two accidents to the propellor; one during an attempt to start and the other, near the finish, when a descent was made into the marsh at South Amboy, N. J., for engine adjustment. The time from Governor's Island, New York, to Philadelphia (86 miles) was 1 hr. 50 min. The return to South Amboy (68 miles, including a detour) was made in 1 hr. 21 min., and the finish was made in 23 minutes more, but only after a delay of 5 hrs. 23 min. The total time in the air was 3 hrs. 34 min.; the average speed going was 46.9 mi. per hr., and returning 51.36 mi. per hr. The machine used was a Curtiss biplane, portions of which were parts of the machine with which Glenn H. Curtiss won the speed prize at the Rheims International Meet in 1909. The propellor substituted after the accident which occurred during the first start was one used by Curtiss in his recent Albany-New York flight.

A high aeroplane flight was made by W. H. Brookins, of Indianapolis, June 13, with a Wright biplane. He rose 4,384 ft., thereby approaching the reported performance of Louis Paulhan at Los Angeles, Cal., Jan. 12 (5,000 ft.). Paulhan's record has been subjected to a correction of —837 ft., which if valid would give the highest record to Brookins.

Certain preliminary injunctions, obtained by the Wright Co. (owning the patents of Orville and Wilbur Wright) against the use of the Curtiss and Farman biplane flyers except with the permission of the Wright Co. and under bond, have been dissolved by the U. S. Circuit Court of Appeals pending trial by permanent-injunction suits, adjudication of the Wright patents and proofs of infringement. Rival aviators are expected to use this opportunity of attempting the many prize cross-country flights recently projected, as they are released from the necessity of a heavy bond.

THE SECOND INTERNATIONAL AVIATION MEET at Rheims, France, is announced for July 3 to 10, and American aeronauts are invited to participate. Among the prizes announced is one of $9,650 for the three aeroplanes which, in all contests in which they participate, cover the longest distances; $5,983 is offered for the greatest distance covered in one flight; $965 for the world's record of distance; $8,685 for the greatest distance in certain specified flights; $1,930 for the shortest time in flying 100 kilos. (62.10 miles); $3,474 for the highest attained altitude; $965 for the record in carrying passengers; $2,985 for the speed record over a distance of 20 kilos. (12.42 miles); $5,558 in 48 parts for daily records in distance, height or speed; $965 for the two army officers covering 50 kilos. (31.05 miles) in the shortest time; $965 for two ladies covering 10 kilos (6.21 miles) in shortest time; $1,933 for a flight outside the aerodrome; $1,930 for the fastest two dirigible balloons; $1,930 for the fastest two kites with passengers. A sum of $4,825 is offered by the London "Daily Mail" and $1,930 as the Michelin Cup. The total of all prizes is stated as $55,545.

AN ENGINEERING EXHIBITION to be held in London Sept. 1 to 26, 1910, is reported by Consul-General John L. Griffiths. It is stated that attempts will be made to have this exhibition the largest and most representative that has ever been held in London. It is announced that attempts are being made to have all important and representative engineering firms secure space for exhibitions and that every tool and appliance connected with engineering will be welcomed. Mr. Griffiths reports that this exhibition should afford an excellent opportunity for American manufacturers of naval, mercantile, marine and general engineering machinery to bring their products to the attention of many possible purchasers from all parts of the world. Particulars and plans may be had on application to Mr. Frederic W. Bridges, Secretary and Manager of the Naval, Mercantile Marine and General Engineering and Machinery Exhibition, 125 Finsbury Pavement, London, E. C.

PANAMA CANAL EXCAVATION during May totaled 2,477,618 cu. yds., a daily average of 99,105 cu. yds. for the 25 working days. This is the first month since December, 1907, that the daily average has dropped below 100,000 cu. yds., although each May in the two years since that date has shown very low totals on account of the prevalent heavy rains. This year the May rainfall was 11.23 ins. as against 5.08 ins. in April.

The amount of concrete laid during May was 107,043 cu. yds. against 96,120 cu. yds. in April, and 483,610 cu. yds. of fill was placed as against 549,271 cu. yds. in April.

A COMPULSORY ORDER TO PURIFY THE WATER-supply of Trenton, N. J., was recently issued by the New Jersey State Board of Health, the order to become effective on June 15, 1910. It is generally understood that any order for action on such short notice must contemplate the use of hypochlorites. We are informed that if the order is not complied with on the date specified, suit will be brought against the City under Chapter 253 of the New Jersey Laws of 1909. It may be added that the Trenton officials have been dallying with the subject of improved water-supply for many years. They have secured and pigeon-holed a number of engineering reports, one as far back as 1900, made by Mr. Allen Hazen, M. Am. Soc. C. E., of New York City. In December, 1909, the State Board of Health served notice upon the Trenton authorities to show cause why they should not furnish their citizens with a pure supply of water. Subsequently Hering & Fuller, of New York City, were engaged to report upon the filtration. Their report was duly received, and it appears that no action has been taken in accordance with its recommendations.

## Personals.

Mr. Geo. B. Foster has been appointed Chicago Sales Manager of the Wisconsin Engine Co., of Corliss, Wis., with headquarters in the Fisher Bldg., Chicago, Ill.

Mr. Wm. L. Austin, formerly Vice-President of the Baldwin Locomotive Works, of Philadelphia, Pa., has been elected President to succeed the late John H. Converse.

Mr. F. E. Trask, M. Am. Soc. C. E., of Los Angeles, Cal., has been appointed Chief Engineer of the Arrowhead Reservoir & Power Co. at San Bernardino, Cal., and will have charge of the construction of the Little Bear Valley dam and other projects.

Mr. Geo. R. G. Conway, M. Am. Soc. C. E., whose resignation as Chief Engineer of the Monterrey Water & Drainage Co., of Monterrey, Mex., was noted in our issue of April 28, 1910, has opened an office as a hydraulic and sanitary engineer at 514 Paulsen Bldg., Spokane, Wash.

Mr. C. L. Harris, General Superintendent of the Southern Ry., at St. Louis, Mo., has been transferred to Birmingham, Ala., to succeed Mr. H. E. Hutchens. Mr. B. G. Fallis, Superintendent of the Southern at Greenville, S. C., succeeds Mr. Harris as General Superintendent of the St. Louis-Louisville lines.

Mr. S. Watts Bowker has withdrawn from his position as General Sales Manager of the Central Foundry Co., of New York City, which position he had held for the past three years. The company is now in the hands of the receiver. Mr. Bowker's present address is in care of the Machinery Club, New York City.

Mr. Lucius I. Wightman, who has been Advertising Manager of the Ingersoll-Rand Co., New York City, for the past six years, has resigned that position and will open an office in New York City as an independent specialist in machinery advertising. Mr. Wightman is a graduate of the University of Colorado, class of 1899. His resignation will take effect Aug. 1.

Mr. Geo. R. Wadsworth, M. Am. Soc. C. E., of Boston, Mass., has relinquished his connections in that city to become Assistant to the President of the Peerless Motor Car Co., of Cleveland, Ohio. Mr. Wadsworth is a graduate of the Massachusetts Institute of Technology, class of 1898, and was employed for several years by the New York Central & Hudson River R. R. as Resident Engineer of the terminal work in New York City. He has been practicing as a consulting engineer in Boston since 1907.

Mr. C. W. Culp, General Superintendent of the Richmond, Fredericksburg & Potomac R. R., has been given the title of Superintendent of Transportation. Mr. S. B. Rice, Road Master, has been made Engineer of Maintenance of Way, and Mr. W. F. Kapp's title of Superintendent of Shops and Machinery has been changed to Superintendent of Motive Power. The authority of Mr. W. D. Duke, Assistant to the President, has been extended to include general supervision of the transportation, roadway and mechanical departments.

Mr. A. M. Munn, Assoc. M. Am. Soc. C. E., has entered the contracting business, and has associated himself with the firm of Callahan Bros., Munn & Reise, of Humboldt, Neb., of which firm he is Secretary. Mr. O. N. Munn and Mr. H. S. Schwaderer have organized the engineering firm of Munn, Schwaderer & Munn, of Humboldt, Neb., to take over the business of A. M. Munn who will act as consulting engineer of the new firm.

## Obituary.

Harold J. Barker, a civil engineer in the employ of H. L. Stevens & Co., at Houston, Tex., died June after a short illness at the age of 26 years. He was a graduate of the University of Wisconsin.

Charles E. Goad, M. Am. Soc. C. E., and M. Can. Soc. C. E., died June 10 at his home in Toronto, Ont., aged 62 years. He was born in London, England, and had resided in Canada about 40 years.

Elisha P. Wilbur, formerly President of the Lehigh Valley R. R., died June 14 at his summer home in the Thousand Islands. Mr. Wilbur was born at Mystic, Conn., in 1838. He entered the service of the Lehigh Valley as a rodman in 1852.

Daniel Egan, formerly President of the American Steel Foundries Co., died June 9 after a brief illness at his home in Philadelphia, Pa. He was 65 years old. His son, Daniel C. Egan, is Vice-President and General Manager of the Keystone Steel Casting Co., of Philadelphia.

William E. Crane, M. Am. Soc. M. E., died May 22 at Duluth, Minn. He was born at Burlington, Conn., in 1847. He was connected with the Benedict & Burnham Co. at Waterbury, Conn., for about 25 years and afterward became Consulting Engineer for the New England Engineering Co., and in this capacity designed several large power plants. He subsequently became Chief Engineer at the Hotel Astor in New York City, but soon left New York for Minnesota in the hope of finding a more healthful climate.

## Engineering Societies.

COMING MEETINGS.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 20-22. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 21-24 Annual convention at Chicago, Ill. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 22-24. Semi-annual meeting at Niagara Falls, N. Y. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-25. Annual meeting at Madison, Wis. Secy., Henry H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 27-30. Annual convention at Jefferson, N. H. Secy., R. W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 28-July 2. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
June 30-July 1. Semi-annual meeting at St. Louis, Mo. Secy., W. M. Mackay, P. O. Box 1818, New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 26-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 16-19. Annual convention at Niagara Falls, Canada. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

INTERNATIONAL CONGRESS OF INVENTORS.—The convention which was to have been held at Rochester, N. Y., June 13-18, as noted in our issue of March 10, page 274, has been postponed until October, the definite date to be announced later.

NEW ENGLAND WATER WORKS ASSOCIATION.—The June outing of the association will be held at Providence, R. I., June 22. The program arranged for the entertainment of members and their guests includes a trip down Narragansett Bay, with dinner at Field's Point, and inspection of the Providence sewage disposal plant and of the water-works pumping station.

NEW YORK ELECTRICAL SOCIETY.—On June 15, the society met in the dining room of the new Pennsylvania station on Seventh Ave. and 32d St. After the meeting and election of officers, the members and their guests were given an opportunity of inspecting the building. The following officers were elected: President, Robert T. Lozier; Vice-Presidents, H. L. Doherty, A. S. McAllister, Ernst Woltmann; Secretary, George H. Guy; Treasurer, Henry A. Sinclair.